# Motorship

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The exceptional performance of this dredge in deepening the channels of the Ohio River is made possible by the

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**DIESEL ENGINES**

Volume XI, No. 3 MARCH, 1926 Price, 35 Cents

*ARTICLES on design, construction and operation of oil-engines and motorships by the world's foremost writers on marine engineering.*

# Motorship

*ILLUSTRATIONS of the newest designs in international merchant motorship and Diesel-engine construction and auxiliary equipment.*



Vol. XI March, 1926 No. 3

# The Story of the Two Bears

## The Old Bear is History and Romance and Tradition. The New Bear is Steel and Oil Engines and Electric Drive

By Capt. C. B. Q. Newman, U.S.N.*

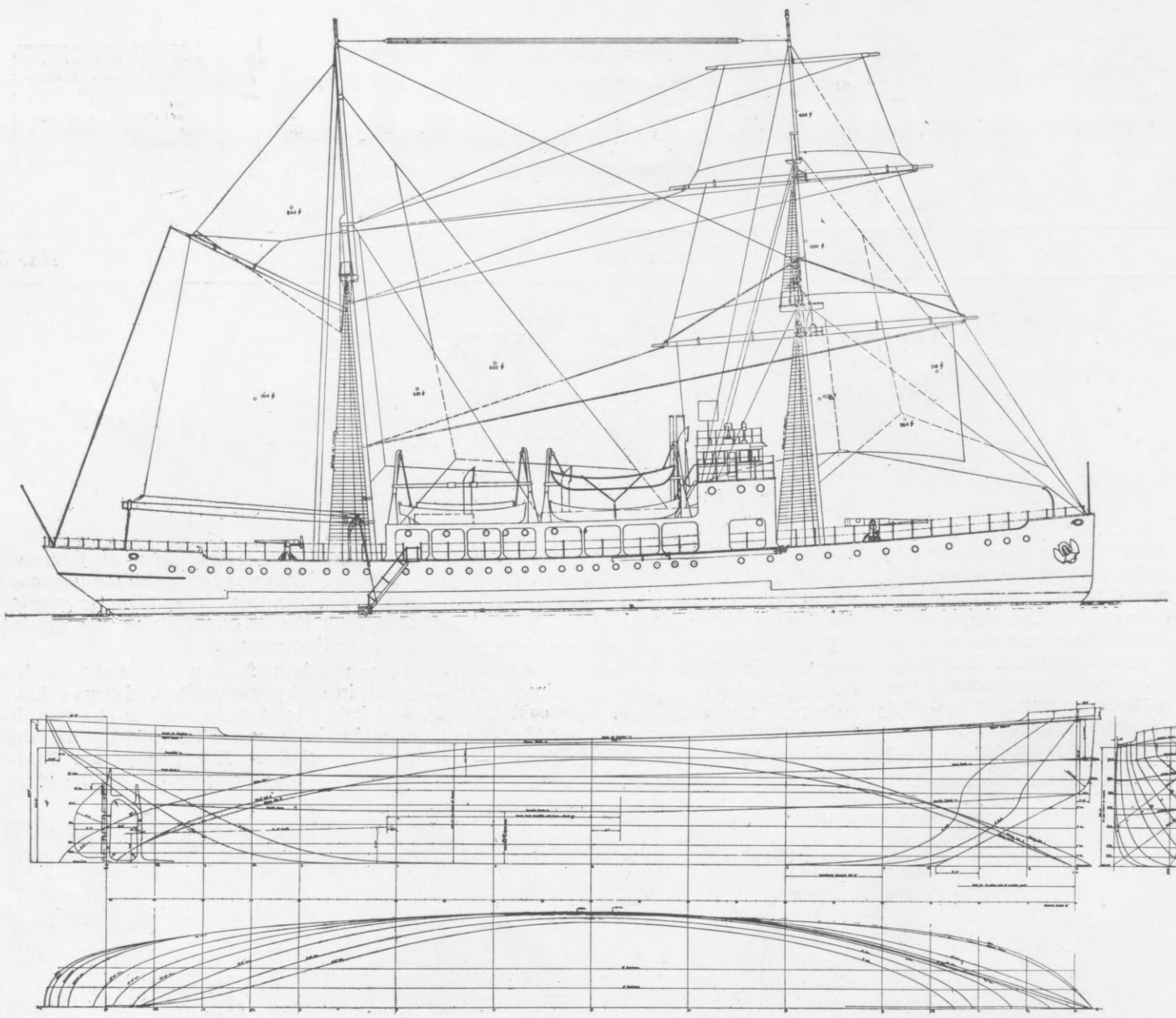
ARCHAEOLOGISTS have recently discovered, under the left fore paw of the Sphinx, the tomb of King Seneferu. It has been there so long they find difficulty in conveying to us a proper conception of its antiquity. The year as a unit of time is far too short, and the century seems not to fit. So they lead us back by more or less easy stages to the beginning of the Christian era; thence another 1000 years back to King Tut, which makes Tut appear quite ancient indeed; and then they double the time from us to Tut and get the approximate date of the demise of Seneferu.

It is thus we try to coax our minds to an appreciation of long periods of years. And so, falling back on the principal of relativity, I remember that the Coast Guard Cutter BEAR is three years older than I am, and hence was built in 1874. They had real ship builders on the banks of the Clyde in 1874, but none better than at Greenock where the BEAR was built, and the Greenock builders never turned out a better wooden ship than the BEAR. Neither has anyone else, for that matter.

She was built for a whaler and spent her youth in that profitable but odorous calling. And being built for a whaler she was designed to buck ice and to resist the crushing pressure of ice. Her frames are 12 in. square and closely spaced. At the water

* Chief Engineer of the United States Coast Guard.

*Coast Guard Cutter Bear "built for a whaler, she was designed to buck ice and to resist the crushing pressure of ice"*



*Outboard profile, sail plan and lines of the New Bear, a steel vessel with Diesel electric drive*

line is a series of transverse oak timbers 12 in. square on 5 ft. centers. A pair of diagonal timbers at each transverse timber brace the frames at the turn of the bilge. Her planking is 6 in. thick, and outside of the planking is iron-bark sheathing, 2½ in. thick. She is solid wood for 7 to 9 ft. abaft the stem—that was to buck ice, and she has bucked it a thousand times.

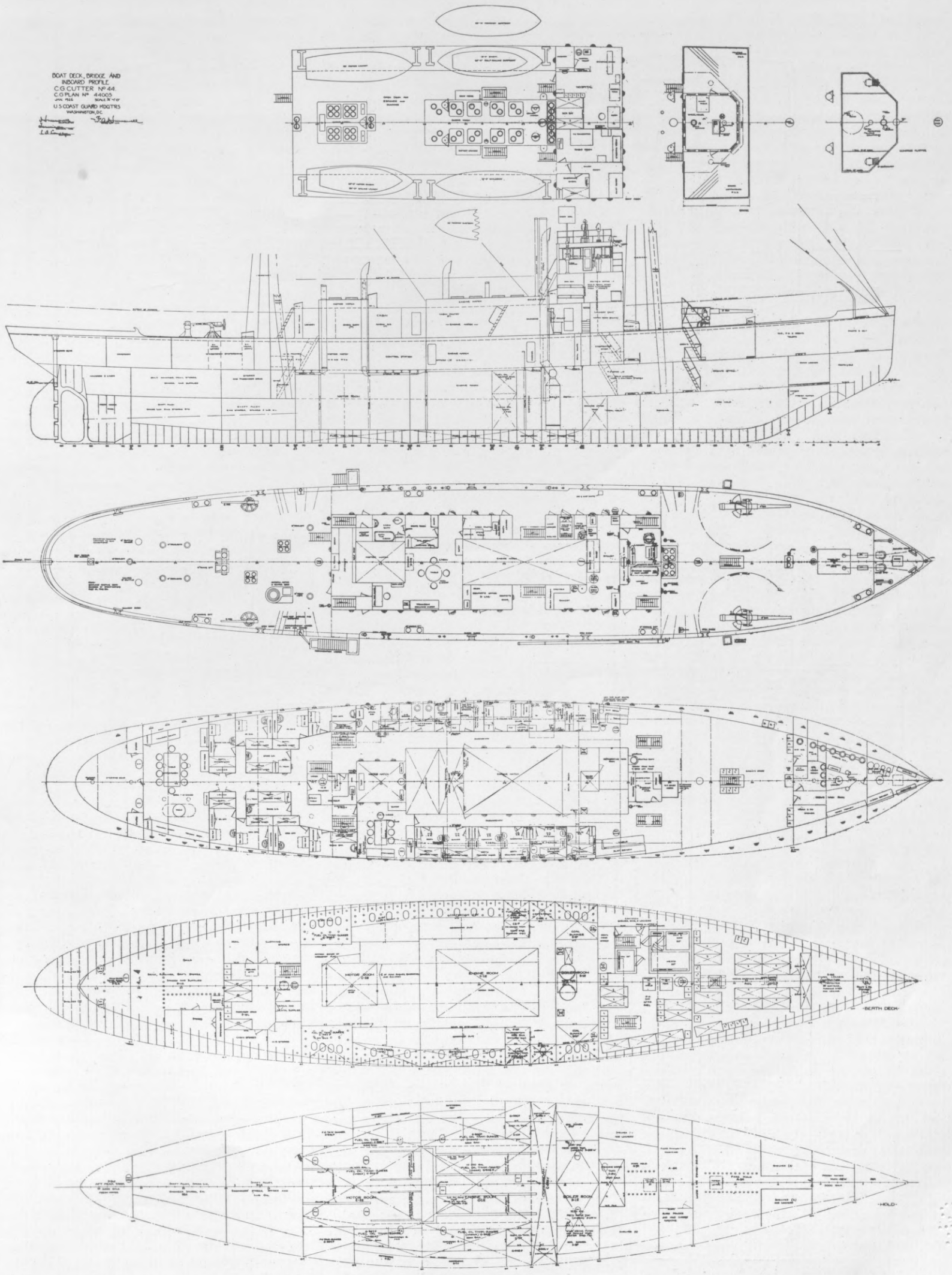
Her machinery was of quite an advanced type for 1874,—a three furnace Scotch boiler and a compound engine that developed about 350 i.hp. She still has the original engine but is using her third boiler. She began her career with a 2-bladed propeller that could be hoisted on deck when the breeze was right for sailing. The propeller was mounted on a short shaft with journals at the ends of the hub and the propeller shaft bearings were carried in an inverted U-shaped crosshead that worked on guides built in the stern frame. The forward end of the propeller shaft was squared and slipped into the enlarged end of the tail shaft, forming a sort of side-engaging clutch.

With the propeller on deck and all conditions favorable, she could clip off 10 knots. It was difficult to estimate her leeway, which might be as much as 100 miles from Unalaska to San Francisco. Now she has a 4-bladed propeller and does not sail as much as she used to.

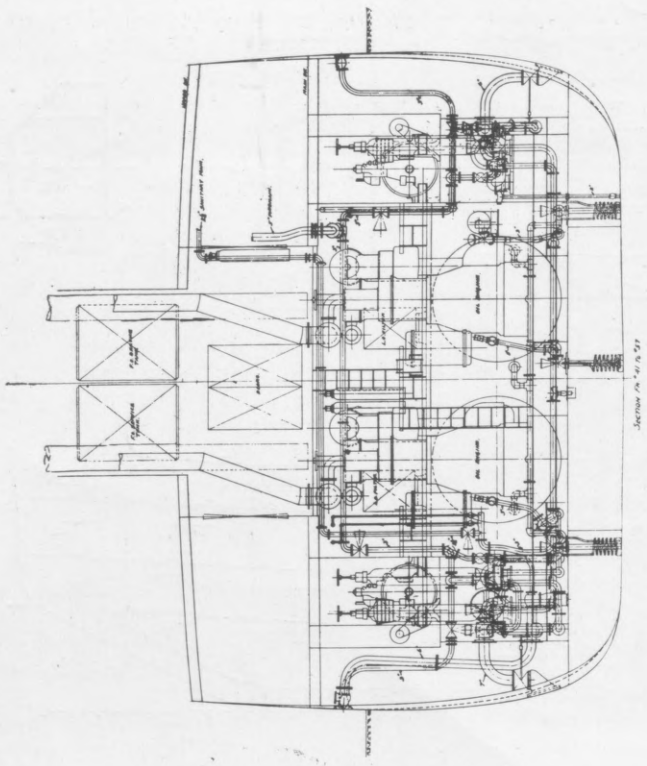
When the BEAR was about 10 years old she forsook the killing of whales and turned to the saving of human life and the alleviation of human misery. The Navy purchased her for the Greeley Relief Expedition, and it was not her fault that another ship found Greeley. After the Expedition had finished its work the BEAR was transferred to the Coast Guard by act of Congress in 1885 and placed in the Alaskan service. Again invoking the aid of relativity, this was 18 years after the purchase of Alaska from Russia and 13 years before the discovery of gold at Nome.

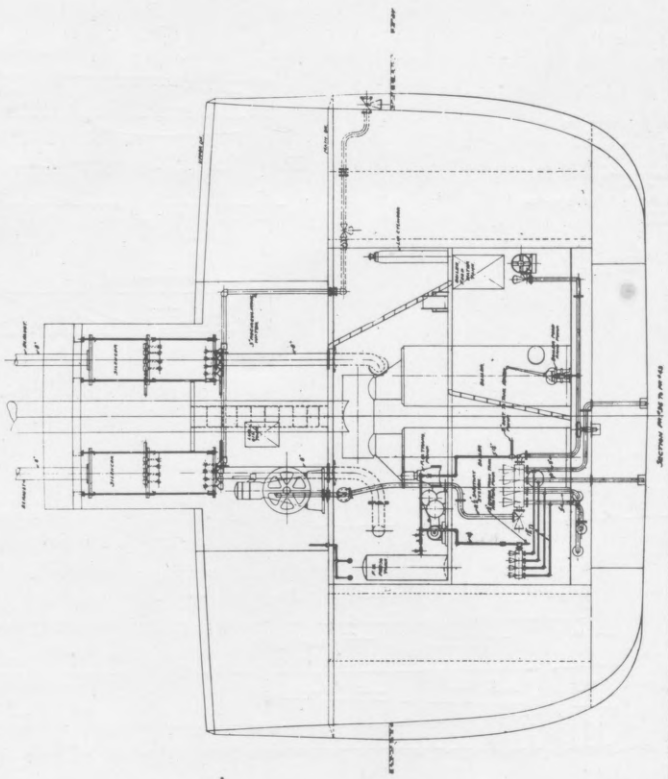
There have been a few high spots in her career during the past 40 years, two of which are of peculiar interest. When the Government decided to introduce domestic reindeer into Alaska, an officer of the BEAR collected and purchased animals all over eastern Siberia and the BEAR delivered them to designated points in Alaska, where they were bred either by Government agents, or by Eskimos under Government supervision. By the winter of 1897-8 the reindeer herds had increased to quite a respectable size. In November 1897 it became certain that the whaling fleet in the Arctic Ocean had been imprisoned by the ice, and the BEAR was dispatched to their rescue. She endeavored to land the rescue party in vicinity of Nome, but found it impossible because of ice conditions. The party was therefore landed at Cape Vancouver, to the southward of St. Michael. The three officers of the expedition, Jarvis, Bertholf and Call, accumulated a herd of 448 reindeer, descendants of those they had introduced, and drove them 1200 miles over land to Point Barrow in the dead of winter and saved 264 men who were facing certain starvation. The three officers who composed the overland expedition were awarded gold medals by act of Congress for heroic service. All three have gone to their final rewards, but the old BEAR still sails the Northern seas.

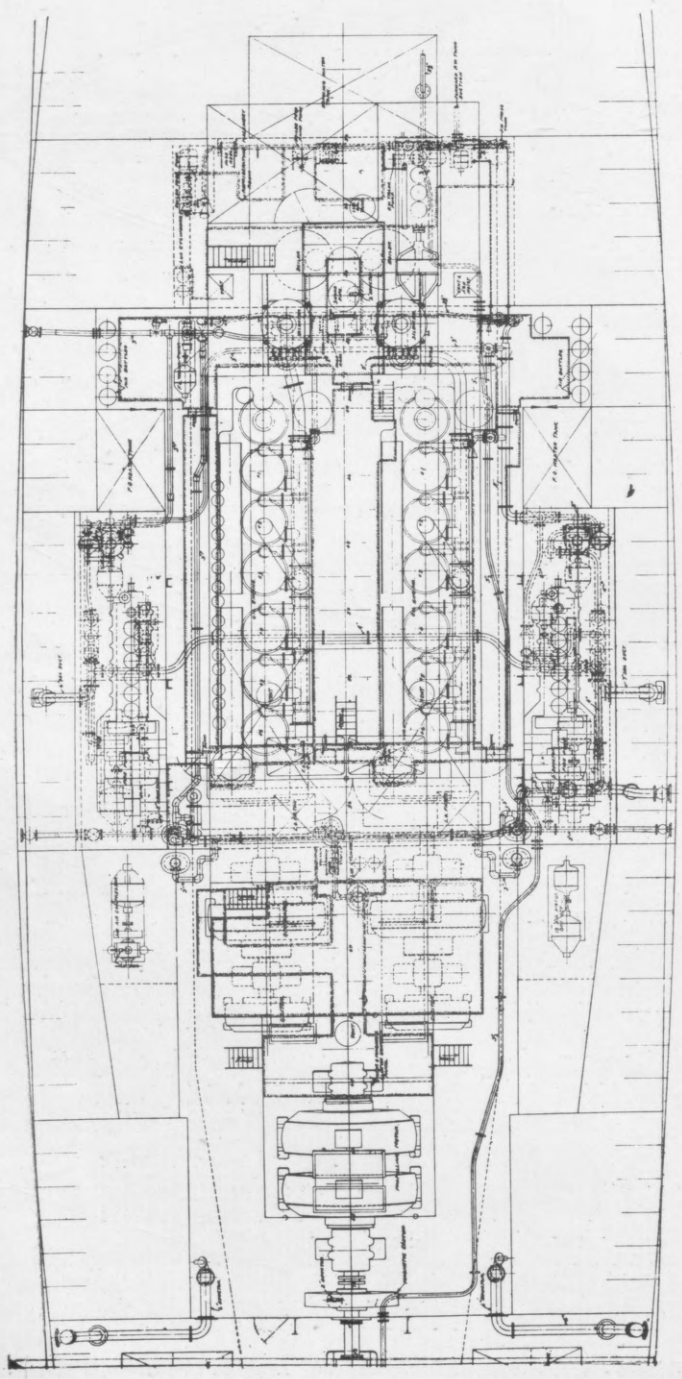
For the rest of her career has been relatively uneventful,—furnishing medical assistance to natives who never saw a physician except the BEAR'S surgeon; administering justice in communities so isolated that the BEAR'S skipper draws more water than the Chief Justice; carrying missionaries and school teachers to places having no other means of transportation, and later carrying their mail and supplies and furnishing the only contact with their former lives; rounding up and bringing out criminals, crooks and destitute persons; and in general representing the might and

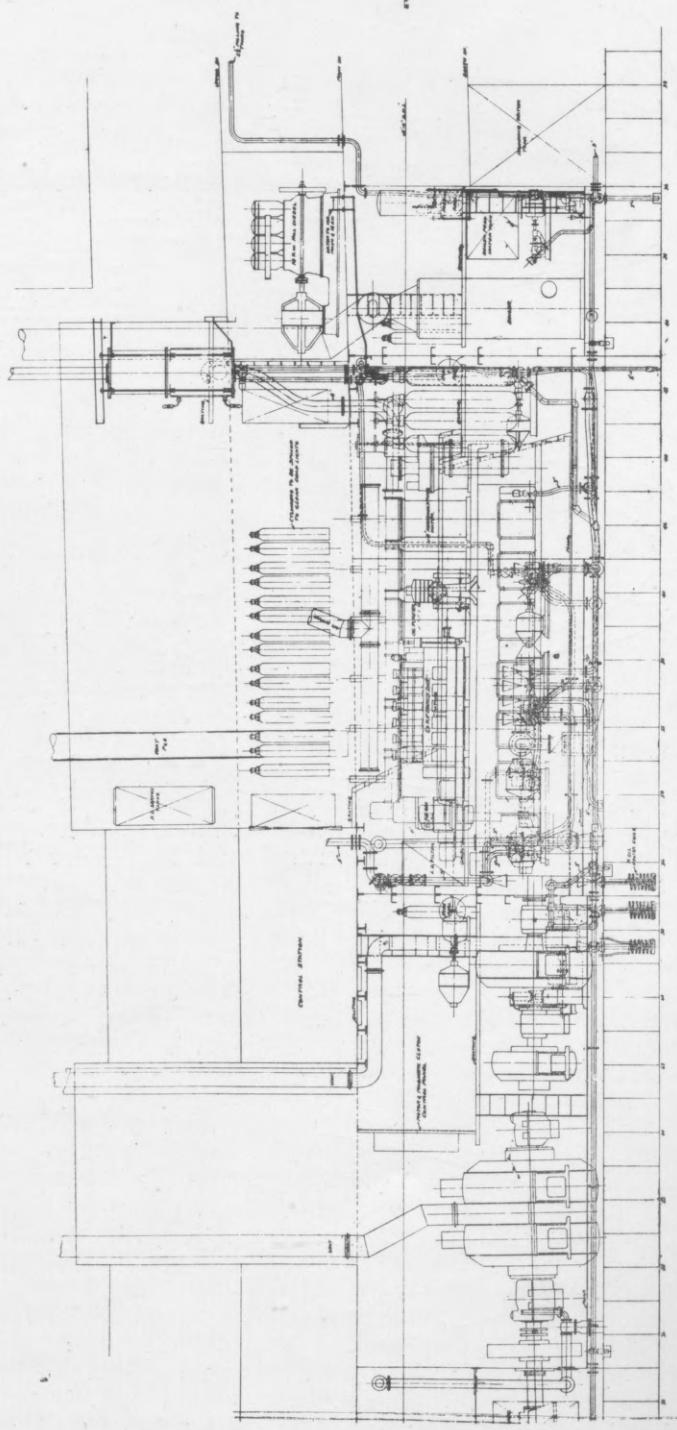



***Inboard** profile and deck plans of the new Coast Guard Cutter, with Diesel electric propulsion, that will replace the famous Bear*









*Elevation, plan and sections of the machinery spaces of the new Diesel electric Coast Guard Cutter to be built for service in Alaskan waters and in the Arctic Ocean*

majesty of these United States in every conceivable kind of situation, legal, economic, domestic, political, and sociological.

The spectacular part of each cruise is taking the King Island natives home from the summer fishing grounds. There is no compulsion about taking them, but it is a big factor in the economic life of a whole village, and by annual observance has become an institution. The population of the village, men, women, children and dogs, journey 90 miles in the Spring to good fishing grounds, going in their skin boats. In the Fall the BEAR takes all the people and dogs aboard and tows the boats with the season's catch back to King Island, the whole proceedings sometimes taking two days to complete.

Opinions differ as to the looks of the BEAR. To some she is the pink of perfection in every detail. Others are willing to concede that she has a pretty good bow, but insist there is something wrong with her sheer—maybe it is the way her deckhouses set—and her stern could easily be improved upon. But everybody admits that towards the end of a cruise she has an air; really, it is more than an air, it is an aroma,—reminiscent of whale oil, yet not whale oil. Nearly everybody aboard has acquired trinkets from the Eskimos, fur mittens, fur caps, mukluks, etc., and these with one or two half-cured walrus heads are responsible for the aura. And it takes quite a while to forget the King Island natives.

At times almost everybody regrets there are not a few more places in her with head room for a normal man. This is of course impossible with the quantity of timber scattered through her. Also it is said that a ship's knee in the middle of a berth, which is the relative location of some of the knees and berths on her, can become tiresome.

But when all the disadvantages have been recited she is still a wonderful ship. Men with the discretion of mature years and a reputation for veracity will tell you of seeing her 'thwartship beams buckle 12 inches due to ice pressure and spring back to normal when she cleared the ice. They will tell you how she was caught in the tide rips at Seymour Narrows, struck the rocks head on, knocked off $14,000 worth of wood and never leaked a drop. According to them life is not really worth while until you are at sea with all sails set and a half gale of wind,—"steady as a church" is the expression. And you would be glad to believe all of it. For the BEAR is more than a ship. She is history and romance and tradition. She is a personality. She has a mind of her own and a soul of her own. She is the BEAR!

*Axiom* 1. *Whatever succeeds her has got to be good.*

This story of the old BEAR, all too brief, is recited here for the purpose of hinting at the background against which the NEW BEAR is designed. And the first question is why not duplicate the old ship? Paraphrasing Mr. Ford's description of his justly celebrated product, "she has taken them there, she has brought them back" for 52 years. But the question is no sooner asked than the difficulties begin to arise. Where shall we find the workers in wood with the necessary experience and skill? the ship's auger that will worm its way through 8 feet of solid oak? the fastenings that will hold wood together for a half century?

Then there is the matter of actual strength of hull as opposed to apparent strength. The most disquieting disclosure of a study of the old BEAR'S design is that her strength is highly localized,—amazingly strong at the water line, but not nearly so strong anywhere else. Lady Luck has sailed with her more than once.

The first consideration, is, of course, adequate and consistent strength of hull. A consistent design is one in which the skin of the ship will support the ice pressure between frames, the frames support the load till it can be transferred to stringers and deck beams, the stringers support the frames and land the load on the bulkheads, and finally the bulkheads support the load without distortion. What an adequate design is no man knows.

Pack ice if not in motion exerts no particular pressure, but ice in motion, and especially in motion in two different directions on the port and starboard sides of the ship, or in motion on one side and grounded on the other, may exert a pressure that is limited only by the crushing strength of the ice itself or the pressure at which it begins to crumble and flow out.

A ship's hull built of whatever materials, which would withstand such pressures would have little value, because it would be practically solid. But steel of a permissible tonnage can be wrought into a structure that will approach the desirable strength much more closely than a hull of any other materials. Hence the NEW BEAR will have a steel hull. The tonnage of steel in the hull is largely determined by displacement, and its distribution among the various members is such as to produce a consistently strong structure.

Two hundred feet is about the limit of waterline length for maneuvering in ice leads. The draft is fixed at 15 ft. by the depth of water in a number of harbors she must visit. Beam and block coefficient are profoundly influenced by the need of displacement to carry the weight of the hull structure. And yet when all the compromises have been effected, the general appearance of lines and body plan contains nothing abnormal or freakish. The cutaway fore-foot, which is one of the most noticeable features, is a concession to the idea that she might some time be able to ride up on the ice and break her way out from a situation where she could not buck out. The chief internal compromise is the spacing of engine room bulkheads which was fixed by the length of the engines, and is somewhat greater than was estimated for maximum hull strength.

Very particular attention has been paid to watertight subdivisions, and the principle has been maintained that she will float and be perfectly safe with any compartment flooded. Flotation is, however, only half the battle,—she should be able to move. And so she has virtually a double hull around the two machinery compartments, the inner hull being composed of the transverse and longitudinal bulkheads and the tank top. The integrity of watertight bulkheads has been most jealously guarded, so that even to go from one machinery space to the other it is necessary to go up to the main deck to get over the bulkhead and then down on the other side.

Coast Guard cutters spend their lives answering SOS from other ships; they rarely send it. They tow other ships many thousands of miles each year, but they would feel degraded at the wrong end of a tow line. This is a natural result of capable and self-confident personnel working with good equipment. But this particular ship spends eight months of each year remote from repair facilities, and she must be self-reliant to an extent known to few ships in the world. And we come now to the problem of finding the best machinery equipment for her. The minimum requirements are: it must not only be good,—it must have demonstrated its excellence; it must have the least possible likelihood of derangements,—but, if disabled, must have the greatest possibilities of quick and easy repair without outside assistance—and finally, as many stand-bys as practicable be provided.

The first champions to enter the lists displayed on their banners "Old Reliable Steam Engine." Old enough, in all good faith, but reliability is another matter. A century and a quarter of familiarity with it has accustomed us to its cussedness and inspired a feeling of confidence in it that is not always justified. And, expressing it conservatively, the steam engine is certainly no more reliable than the steam turbine or the oil engine. Neither the steam engine nor the steam turbine can be readily repaired on board, and neither of them offers any standby possibilities whatever on a single screw ship.

Still speaking guardedly, an oil engine of seasoned design and proved excellence is as reliable as any other form of prime mover; its usual derangements can be quickly rectified; and, in conjunction with electric propulsion, it offers standby possibilities which are limited only by the desire for standbys.

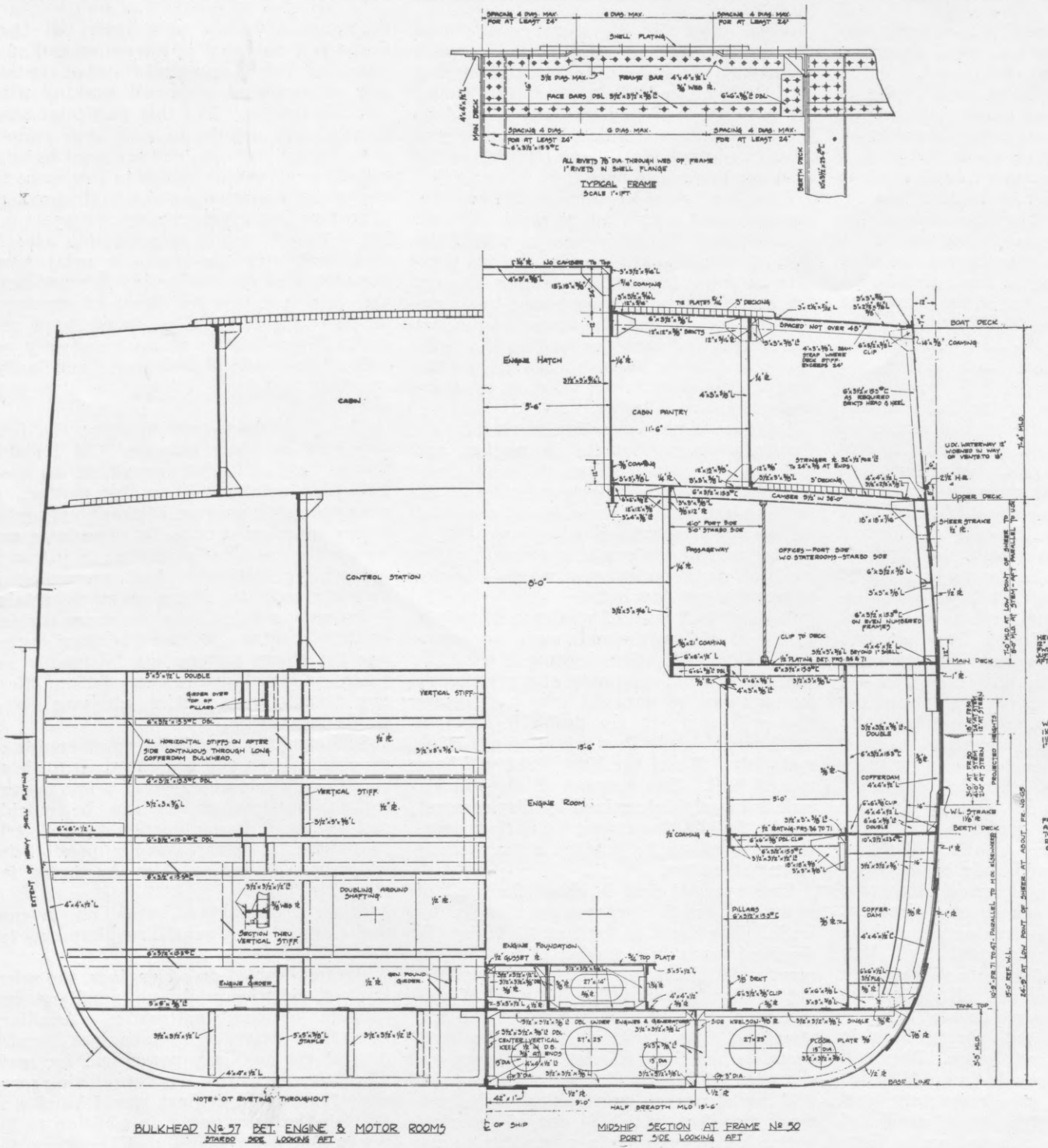
Electric propulsion needs no defense under any of our essential requirements for this ship.

Having decided on oil engines, the selection of electrically driven auxiliary machinery becomes automatic. Auxiliary generators driven by oil engines furnish current for auxiliary power and for main machinery excitation. But at cruising speed one of the main engines would be able to furnish auxiliary power in addition to the power for main drive, and therefore the direct connected exciters are of appropriate size, so that one main engine will drive the ship and everything in her.

The main generators operate on the Ward Leonard system either singly or in series, and the main motor has two armatures on one shaft so that either or both together can be used.

The deck machinery is electrically driven. If all the deck machinery and all the engine room auxiliaries were operated together the load would be too great for one of the auxiliary generators. A system of selective switching is provided so that it is not possible either to impose too great a load on one auxiliary generator or to run two generators in parallel. This is important because both of the exciters and both auxiliary generators are available for any of the purposes named and it is not possible to provide for parallel operation.

Question No. 1001.—What happens when the rotating propeller strikes solid ice? Answer.—the blades are wiped off. At least that was the answer for a long time. But it is possible to build a magnetic clutch coupling, two face plates with brake lining




riveted to one of them and with a magnetic field to get the contact pressure. Hundreds of them are in use on shore. By adjusting the excitation of the clutch field so that it will just carry the necessary torque, any excess torque will cause the clutch to slip, thereby relieving the propeller of the blow due to the momentum of the motor armature. May be the blades will not wipe off after all. When the ship is out of the danger of ice, the two halves of the coupling will be solidly bolted together.

Controls for the propelling machinery and the distribution switchboards for the auxiliary power and lighting circuits are installed in a control room on the main deck. The engineer officer can look down forward to his engines and auxiliaries and aft to his generators and motor; and in case his presence is needed in either place he has only to drop down a ladder. There has been no temptation to install bridge control, for we still adhere to the idea that the man who is operating a machine ought to be where he can see it.

Standardization has been carried out wherever possible. In conformity with this idea, both of the main engines have the same direction of rotation, making all parts strictly interchangeable. The same is true of the two auxiliary engines. Where equipment was naturally almost alike it was made exactly alike. This was particularly the case with auxiliary motors. There were instances where the machine speeds were inherently different, and the powers dissimilar, and yet it was found that the same motor at different speeds would fit two cases. This simplifies the spare parts problem. Nothing is working near its maximum capacity, the idea being that longer life and consistent performance will more than offset the slightly greater first cost.

In procuring the machinery for the NEW BEAR the Coast Guard is following the policy, adopted several years ago, of purchasing everything direct from the manufacturers and furnishing the equipment to the shipyard to install. The size, type and manufacture of each piece of machinery is given in the shipbuilder's specifications. Under this plan each machinery builder is directly responsible to the Government for the performance of his machine; the shipyard is responsible for a correct installation; and the Government backs its own judgment on what the performance of the ship will be.

The plan has many advantages, the most obvious being that the machinery builder makes one quotation to the Government direct, instead of a large number of quotations to all shipyards desiring to bid. He thereby saves the endless repetition of bids which is as fruitless as it is expensive. He gets his pay when the machinery is shipped. The shipbuilder nowadays rarely builds any machinery that he installs, and he is saved the uncertainty as to whether he can get approval on a particular machine, he is saved the labor and expense of procuring bids, he avoids the necessity of financing the purchase of the machinery, and last, but not least, he is not responsible for the performance of the ship. In short he does not gamble. From the Government's point of view, there is a real saving in money. Con-

trary to the belief entertained in some quarters, any governmental agency that can specify what it wants and has a reputation for paying its debts, can purchase in the open market for prices less than are paid by private concerns for the same articles.

The English language probably contains no other words that have cost the Government as much as the phrase "to the satisfaction of the inspecting officer." The sole function of that officer is to see that the specifications are complied with, and his satisfaction or lack of it ought not to enter into a contract. The man who needs to be satisfied is the man who writes the specifications, and the time when he ought to be satisfied is before he writes them.

Ship propulsion ideas are in such a state of flux that the question most frequently raised in connection with the NEW BEAR is the question of obsolescence. The ballyhoo of the newer types of engine is ringing the welkin, and it is a pity we could not wait a year or two so as to take advantage of whatever is good. Short stroke, high r.p.m., alloy pistons, cast steel cylinders, new kinds of fuel injection, wrought steel instead of cast iron for tension, supercharging, double-acting,—all tending to lighter weights,—are just around the corner. And there is no question that this ship is going to carry a tremendous load of cast iron that will ultimately be found not to have been needed. But keeping in mind the extremely detached duty she is to perform, a development that has just turned the corner will not do. Only seasoned and time tried principles and equipment can even be considered. And so we have main engines that have been virtually unchanged for 15 years, auxiliary engines that have been in operation for several years and are of a conventional design besides, generators and motors that were designed when Steinmetz was a young man, controls on which all patents have expired and auxiliary machinery of stock types. The only novel idea in any essential part of the machinery equipment is the magnetic clutch, and if that fails to do what is expected it will be bolted together and forgotten.

This article has been an effort to convey an idea of the old ship and her duties with the resulting effects on the new ship.

In 1978 the NEW BEAR will be as old as the old BEAR is now. During the cruise of that year she will carry a passenger whose name is not on the muster roll. For I am coming back from the Elysian fields to verify my present belief that the BEAR of 1926 will be as good a ship at the age of 52 years as the BEAR of 1874. I hope for no less—I could ask for no more. If a Greenock shipbuilder of 1874 can also make the cruise, we shall have a great time joshing each other, and the end of the cruise will probably find us both happy.

The plans give a very clear idea of the hull and of the general nature of the machinery installation. A general description is as follows:

### Characteristics of Hull

Length between perpendiculars 200 ft. 0 in.
Length, overall.....216 ft. 6 in.
Breadth, molded ..... 39 ft. 0 in.
Depth, molded ..... 24 ft. 9 in.
Draft ..... 15 ft. 0 in.
Frames spaced..... 2 ft. 0 in.

All frames below deck are 16-inch web frames.

### Thickness of Shell Plating:

W. L. strake, 1¼ in. from stem to fr. 7., 1⅛ in. from fr. 7 to fr. 68, 1 in. from fr. 68 to stern.
W. L. strake to main deck and W. L. strake to turn of bilge, 1 in.
Elsewhere, ½ in.

### Characteristics of Machinery

Steering gear, electric-hydraulic.
Windlass and capstan, electric motor drive.
2 main engines, 600 b. hp., 6 cylinders, 17 in. x 24 in., 200 r.p.m. McIntosh & Seymour.
2 auxiliary engines, 90 b. hp., 6 cylinders 6½ in. x 8 in., 500 r.p.m., Winton.
1 auxiliary engine, 24 b. hp., 4 cylinders, 4⅜ in. x 8 in., 550 r.p.m. Hill.
2 main generators, 410 kw., 250 volts, 200 r.p.m.
2 exciters, 75 kw., 120 volts, 500 r.p.m.
2 auxiliary generators, 60 kw., 120 volts, 550 r.p.m.
1 main motor, double armature, 1000 s.hp., 120 r.p.m.
1 motor-generator, 18 kw., 220 volts, a.c., 120 volts d.c.

The foregoing electrical machinery, main thrust bearing and thrust shaft, all auxiliary motors, main and auxiliary controls, all switchboards, and all power cables, General Electric Company.

### Type of Capacity of Pumps

2 fire pumps, centrifugal, 250 g.p.m., 100 lb. pressure, Warren.
3 circulating pumps, centrifugal, 250 g.p.m., 35 lb. pressure, Warren. (These supply all low pressure salt water requirements.)
1 tank heater circulating pump, centrifugal, 35 g.p.m., 50 lb. pressure, Warren.
1 portable sump pump, Warren.
1 fuel oil transfer pump, screw, Quimby.
1 boiler feed pump, screw, Quimby.
1 boiler feed pump, hand, Goulds.

### Other Machinery Equipment

14 bilge ejectors, Schütte & Koerting.
1 boiler injector, Schütte & Koerting.
1 refrigerating plant, 2-ton, York.
2 heating boilers, Coatesville Boiler Works.
1 air horn, Strombos.
1 auxiliary air compressor, Winton.
1 whistle air compressor, Westinghouse.
1 fire extinguisher system, Lux, Kidde.
1 hydro-pneumatic fresh water system, Meyers.
1 fuel oil purifier, De Laval.
1 lubricating oil purifier, De Laval.

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Newport News Shipbuilding & Drydock Co. has been awarded the contract for the construction of the hull of the NEW BEAR and installation at a price of $585,000.

# Grace Line Orders 2 Motorships

CONTRACTS for two 17-knot motorships of 14,000 tons loaded displacement were let last month by W. R. Grace & Co. of New York, operating the Grace Line between New York and the West Coast of South America. They will have accommodation for 160 passengers and capacity for about 7000 tons of cargo and will be the finest, fastest and most comfortable ships running between the United States and the West Coast of South America.

Their dimensions will be 485 ft. length overall, 63.9 ft. beam and 36.6 ft. molded depth, and for propulsion they will have two Sulzer engines of 4000 s.hp. each, driving twin screws, an aggregate of 8000 s.hp.

They will fly the American flag, but are to be built abroad, the order for the ships having been placed with the Furness Shipbuilding Co. of Middlesbrough, England, and the engines entrusted to Sulzer Bros., of Winterthur, Switzerland. The foreign firms were awarded the business because of lower prices.

W. R. Grace & Co. operate four passenger and cargo steamers of about 3000 tons gross each in the West Coast of South America service, and they are also managing the m.s. ASHBEE and the m.s. JACKSONVILLE for intermediate freight in the same service. Between California and ports on the West Coast of Central America they run the m.s. CITY OF PANAMA and the m.s. CITY OF SAN FRANCISCO under the Panamanian flag. They have, however, not hitherto owned nor operated any ships as big or fast as the two large motorvessels just ordered.

# Progress on U. S. S. B. Conversion Program

FIRST of the engines for the Shipping Board's Diesel conversion program, the 2900 s.hp. Worthington double-acting set is due to complete its 30-days non-stop full power test on Mar. 4. One of the McIntosh & Seymour 2700 s.hp. single-acting engines for the same program was started on its 30-days' trial on Feb. 26. A 3000 s.hp. Busch-Sulzer 2-cycle set is due to begin its long full power trial the first week in March.

Tenders for the installation of Busch-Sulzer engines, with auxiliary machinery, and for hull alterations, in two ships selected by the Shipping Board for conversion from steam to Diesel power were opened by the Board last month. Bidders were given the choice of two out of the three following ships—SEMINOLE, CITY OF DAYVILLE and SAWOKIA.

All the firms which bid on a single ship selected the SEMINOLE lying at Hoboken, N. J., and they all quoted 120 days. The Federal quoted 170 days and 195 days respectively for the SEMINOLE and SAWOKIA, while Newport News gave 130 days and 140 days respectively for the SAWOKIA and CITY OF DAYVILLE.

### List of Shipyard Bids

| NAME OF BIDDER | ONE SHIP | TWO SHIPS |
|---|---|---|
| Bethlehem S. B. Corp..... | $496,266 | ..... |
| Federal S. B. & D. D. Co.. | ..... | $881,380 |
| Morse D. D. & R. Co..... | 438,200 | ..... |
| Newport News S. B. & D. D. Co..... | ..... | 771,900 |
| Sun S. B. & D. D. Co..... | 505,774 | ..... |
| Todd Shipyards Corp..... | 451,456 | ..... |

These prices are higher than quoted for the Worthington installations last December, due almost entirely to differences in the engine characteristics. Comparison can be made with the figures published on p. 23 of the Jan., 1926 MOTORSHIP.

Some time this month invitations will be issued for bids on the shipyard work on the vessels to be equipped with the Mc Intosh & Seymour single-acting engines.

FOR the Maryland Pilots Association a boat with De La Vergne engines and Falk gears is to be built by Cramp's.

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A 65 ft. tug is being built in Seattle for shipment in knock-down form to the Somers Lumber Company at Somers, Montana. She will have a 180 hp. Diesel engine.

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Don Lee, of San Francisco and Los Angeles, has ordered a twin screw 600 hp. Diesel yacht, 141 ft. long and 23 ft. 6 in. beam, to be built by the Los Angeles S. B. & D. D. Corp.

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A double-end drive ferryboat has been ordered by the Cooper River Ferry Commission of Charleston, S. C. She will be 120 ft. long, 35 ft. beam and 6 ft. 6 in. draft with a 360 hp. Diesel engine.

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Last month the motor tanker GULFCREST, 13,000 tons d.w.c. and 3,000 i.hp. was launched at Camden, N. J., by the American Brown Boveri Electric Corporation. This vessel, which was laid down to the yard's account, was purchased in January by the Gulf Refining Co. and will be used in coastwise service.

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Mrs. M. K. Rindge and Mrs. M. H. Adamson of Los Angeles are having a 100 ft. Diesel engined yacht built in Seattle to designs by L. E. Geary. They plan to leave Seattle in June for a two months' cruise in British Columbia and Alaska waters before taking the yacht south to Los Angeles. The boat, which will be named MALIBU, will be 100 ft. long, 16 ft. 6 in. beam and 7 ft. 3 in. draft, with twin 4-cylinder 120 hp. Washington Estep engines. A 6 hp. Bolinder engine will drive the auxiliary generator.

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Another Diesel towboat has been ordered by the Diamond P. Transportation Co., of Philadelphia. It will be slightly bigger than either of the two other Diamond P. motor tugs, HUSTLER built in 1923 and SONNITEP built in 1924. The new boat will be 87 ft. long overall, 79 ft. between perpendiculars and 21 ft. beam with a depth of 11.6 ft. For power she will have a 400 hp. Ingersoll-Rand, the same make of engine as the two other boats have. Contract for the hull has been let to the Spedden Shipbuilding Co. of Baltimore, Md.

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## United Fruit Co. Charter

Chartered for five years to the United Fruit Co. at a reported figure of $13,300 per month, a twin-screw motorship of 104,000 cu. ft. fruit capacity has been ordered from the Götaverken yard in Gothenburg by Titchfield, Ltd., of Oslo, Norway. This ship will measure 267 ft. between perps., 37 ft. 6 in. molded breadth and 24 ft. molded depth to the upper deck. There will be two holds, with the motor room between them, and 'tween deck space, all well ventilated as required for the fruit trade between the West Indies and American West Coast ports. For propulsion there will be two Götaverken-B. & W. trunk piston engines developing together 2600 i.hp. at 170 r.p.m., and two auxiliary Diesel engines of the same make will drive generators of 66 kw. capacity each.


# Motorship

*Trade Mark Registered*
Founded 1916


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Readers are invited by the Editor to submit articles, photographs or drawings relating to motorships, marine oil-engines or auxiliaries. Contributions used in the magazine are paid for on the 15th of the title month of issue, and other contributions are returned as promptly as possible.


An understanding between the Dollar Line and the Navigazione Libera Triestina has been arranged according to the Genoa correspondent of *Fairplay*, the British shipping weekly. It is stated that this covers the operation of steamship services between Italy and the Pacific ports of the United States, and relates particularly to schedules and agencies. It is added that stock has been exchanged between the two companies.

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JAVANESE PRINCE, the first of the five 14 knot motorships ordered in Germany by Furness Withy for its Rio Cape Line between New York and the Far East called at Baltimore, Md., last month and loaded for British ports. Her next outward passage from the United Kingdom will bring her to New York, prior to which date, however, the MALAYAN PRINCE, the second vessel completed for the line, is expected to load at New York. ASIATIC PRINCE, the third of the quintet, is nearly ready.

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MONTROLITE, a tanker of 15,600 tons d.w.c. and 9,900 tons gross was delivered last month to the Imperial Oil Co., Ltd., of Toronto, Canada, and sent on her maiden voyage to Tampico. She is 510 ft. long b.p., 68 ft. molded breadth and 38 ft. depth. Drawing 28 ft. of water she has a displacement of 22,500 tons. To give her a speed of 11 knots she has two Krupp 2-cycle, 4-cylinder engines developing 1600 s.hp. each at 92 r.p.m. For auxiliary power she has two Diesel generator sets, one of 100 kw. capacity and the other of 45 kw. capacity with, in addition, a Diesel generator-compressor set with a 100 kw. dynamo and a 2-cylinder air compressor with a capacity of 350 cu. ft. of free air per minute.

PORT HOUSTON, the Diesel-electric fireboat for the Port Commission of Houston, Tex., was launched last month at the Harlan plant of the Bethlehem Shipbuilding Corporation.

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Bids are sought by the Navy Department for six electric generating sets consisting of 8 to 10 kw. d.c. generators, 125 volts, direct connected with kerosene or Diesel engines.

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A 12,000 ton tanker for the Deutsch-Amerikanische Petroleum Ges., a subsidiary of the Standard Oil Co. (N. J.), was launched last month at the Howaldt works at Kiel, Germany.

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An installation of a 6-8 hp. Hill engine with McNab-Kitchen maneuvering rudder is being made in a small gillnet boat by the McGowan Packing Co. of McGowan, Wash., as an experimental installation.

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OLIVEBANK, the seventeenth motorship built by Harland & Wolff for the Bank Line of Glasgow was delivered last month. She is a vessel of 5200 tons gross. Three vessels of similar type for the same owners are still under construction.

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The Nippon Yusen Kaisha is reported to have contracted with the Kawasaki Dockyard Co., Kobe, for three vessels similar to the President class of the American service, for operation between Japan and San Francisco. The Japanese government will subsidize the line to an amount which may be as high as $1,400,000.

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A motorliner of 7,300 tons gross is now being operated by the Osaka Shosen Kaisha on the Kobe-South America run. It was built at the Nagasaki yard of the Mitsubishi Zosen Kaisha and is 449 ft. long, with Sulzer engines aggregating 4,500 s.hp. driving twin screws. Accommodation is provided for 40 first class, 102 third class cabin and 588 third class ordinary passengers. The deadweight capacity is about 10,000 tons.

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## Furness Withy Eastern Service

A new 14 knot 10,000 tons d.w. motorvessel MALAYAN PRINCE, which will initiate the improved Furness Withy service between New York and the Far East, is scheduled to sail from New York on Mar. 25 and from Newport News, Mar. 27, for Japan, China and the Philippine Islands, returning to Boston and New York via the Dutch East Indies and Straits Settlements. She is 440 ft. long with a breadth of 60 ft., and on a draft of 27 ft. 6 in. will have a sea speed of 14 knots. For propulsion she has two B. & W. type 8-cylinder single-acting engines built by the A. E. G. in Germany, capable of developing about 8,000 i.hp., which is estimated to give the vessel a maximum speed of 14½ knots loaded. These engines, contrary to the usual A. E. G. practice, are not fitted with superchargers. Like her sister vessel the JAVANESE PRINCE, which has already made one call at Baltimore, the MALAYAN PRINCE made a speed in excess of 16 knots in ballast on her river trials. The other three vessels of the line will be named the ASIATIC PRINCE, CHINESE PRINCE and JAPANESE PRINCE, all built by the Deutsche Werft.

# Ford Policies Displayed in East Indian

## Seeks Transportation Economy and Service in Owning Ships and Wants Best Crews to Man Them

TO understand why the EAST INDIAN differs in its internal arrangements from other ships, why its operation departs from general shipping practice and indeed to comprehend why the Ford Motor Co. has entered the shipping business, one needs to take account of the particular features of the Ford organization which have a direct bearing thereon.

At the present time the export business in Ford products may be assumed to bear to the total export of American automobiles about the same relation as the production of Ford machines bears to the total automobile production of this country. During the year 1925 a total of 1,990,995 cars and trucks, 104,168 Fordson tractors and 8,415 Lincoln automobiles were produced by the Ford Motor Co. Of these huge quantities about 15 per cent were exported. Based upon an average of say, 110 cu. ft. per ton d.w. the Ford exports during 1925 could therefore be stated to have demanded 38,058,224 cu. ft. of shipping space and to have amounted to 319,482 tons d.w., allowing 15 per cent loss of space in stowage. This is equal to 76 full cargoes for a ship of the capacity of the EAST INDIAN.

Hitherto the Ford exports have helped to fill the holds of steamers sailing from the North Atlantic seaboard to practically every country in the world. This freight has been eagerly sought by all the large shipping lines, both on account of its large volume, as well as on account of its regularity. Like the other huge American organizations which enjoy a big foreign trade the Ford Motor Co. conducts its foreign business in a highly efficient manner. For many years huge concerns like the Standard Oil Companies, the U. S. Steel Corp., the International Harvester Co., the meat packing firms, Western Electric Co., Singer Sewing Machine Co. and the Remington Typewriter Co. have given to the world continuous demonstrations of success in foreign trade unexcelled by the best that has yet been achieved by the British or German houses which are so often regarded as the world's leaders in foreign business. Of these companies only the leading oil concerns and the U. S. Steel Corp., through its subsidiary the U. S. Steel Products Co., make shipments which bulk largely enough to have justified them in operating their own fleets of vessels.

The Ford Motor Co. has now joined this class. As yet its ships are few. Under the American flag it operates the S. S. ONEIDA and S. S. ONONDAGA, which are now joined by the M. S. EAST INDIAN. Other vessels have been operated for it under foreign flags like the M. S. AEGIR, a converted German cruiser which has for some years carried cars from the Ford plant in Copenhagen to various ports on the Baltic. Gradually the number of vessels undoubtedly will be increased.

Under the present methods of organization only three Ford manufacturing plants are operated in foreign countries, one in Canada (which supplies nearly every part of the British Empire except the United Kingdom and Ireland) one in England and one in Ireland. For all other countries the manufacturing is done at the Detroit plant, but in general the assembly is done abroad. There are 14,000 sales and service dealer connections in foreign countries.

Just in the same way as parts are shipped from the Detroit plant to the 35 assembly plants located in the United States so are parts shipped from Detroit to about 20 different assembly plants in various parts of the world. The erection of the machines is done at the assembly plants. In this way in the course of the year enormous economies are made in transportation charges. The actual worth of these economies is not known, but after they have been made the Ford Motor Co., through its various activities, pays something like $150,000,000 a year in transportation charges.

Differences between domestic and foreign shipments are namely, (1) everything for foreign shipment is heavily crated, (2) dealers in foreign countries can receive, if they so desire, a knock-down car for individual assembly, and (3) the coach work is finished in different colors to suit different national tastes. In most other respects the foreign shipments follow the same plan


*Loading the East Indian directly from railroad cars at an open pier in order to save rehandling of the cargo*

as domestic shipments; standard parts are received from the manufacturing plants and assembled in a line exactly as at Detroit—all branches operating under the same system, using the same standard tools, building cars in the same way and all paying high wages to attract the best workmen. The largest of the European plants are in Copenhagen, Paris and Trieste.

The EAST INDIAN on her first transatlantic voyage is loaded with cases of standard parts and knock-down automobiles for the assembly plants at Trieste, Barcelona, Antwerp and Copenhagen. With its large volume of foreign shipments the Ford Motor Co. is in a position to give its vessels full cargoes outward bound. For homeward cargoes it will be in competition with other companies' ships, although there is no doubt that it can influence a certain amount of return freight. In this respect the Ford Motor Co. faces the same problem as the Isthmian Line of the U. S. Steel Products Co. has successfully coped with. That the Ford Motor Co. will ever endeavor to carry all its own foreign shipments in its own vessels is highly doubtful. To the smaller assembly plants abroad shipments will probably be made more economically by regular cargo lines.

There seems to be a tendency for the concentration of the foreign business at one assembly plant in the East. At present the Kearny (N. J.) plant seems to be the chief source of the shipments, but with the purchase by the company of the old Roach Shipyard at Chester on the Delaware it is thought that a special export plant will be established there.

This brief outline of the foreign activities of the Ford Motor Co. serves to show that the advent of Ford vessels on the ocean is not inspired by altruistic motives, but is the natural outcome of the Ford policy to control every ramification of its activities so far as this can be economically done. It controls its own iron mines, coal mines and lumber supply and operates ore carrying motorships on the Great Lakes. The Detroit, Toledo & Ironton railroad, the Ford railway, besides handling coal from the company's mines to Detroit, also affords exceptional freight shipping advantages as it connects with practically every transcontinental line. When these facts are borne in mind it becomes plain that the high scale of wages paid to the men aboard the Ford ships and the unusual provision made for their comfort spring only from the desire to obtain the best possible men with the object of obtaining the best possible operation. There is no question at all of any effort to raise the wages in the merchant marine service.

In another article will be found a detailed description of the superior accommodation provided for the entire complement. The comfort of everybody has been studied in detail, with the intention of helping to make a happy ship. In a book entitled "The Ford Industries" the statement is made that "The Ford Motor Co. wishes to make a Ford job so attractive that every man will put forth his best efforts to keep it. The Company offers high wages, ideal working conditions and permanent employment." The policy there expressed rules in every branch of the Ford organization and applies as well to the ships as to any branch or department ashore. Everybody aboard has been given to understand quite plainly and definitely that he has to consider the happiness of everybody else. This, of course, is not to be achieved at the expense of discipline, but it has to prevail. During the course of the several days we spent aboard obtaining photographs and material for the articles published in this issue we noticed very distinctly that everybody aboard worked industriously and cheerfully. Nobody was loafing, nobody was kicking. The EAST INDIAN appeared to be an exceptionally happy ship.

To some extent it would seem as if the EAST INDIAN is to be regarded as a Ford Motor Co. branch and its efficiency and economy studied from that angle. Every modern aid to navigation has been included in the equipment and every modern aid to engine operation is to be found in the engine room. It seems as if the vessel had been given the finest tools to work with, so that she can have the very best chance to operate in the most efficient manner. The details of the navigating equipment, machinery installation, fire fighting appliances, etc., are dealt with elsewhere in this issue. Most of it has already been tried in other vessels, but some of it is entirely new in this ship. The Sperry recording engine-room telegraphs, for instance, were specially designed at the suggestion of Ford engineers.

Apparently minds accustomed to making provision for all operations in Ford plants to be checked could not be satisfied with the old established marine practice of relying upon verbal testimony regarding many orders from the bridge. With the ordinary number of deck officers, it is, of course, impossible to expect that a log should be kept of all orders given on the engine room telegraph. A log is, however, generally kept in the engine room showing the orders received. What the Sperry Company was asked to produce was an instrument that should automatically record every moment of the telegraph levers on the bridge and this has been accomplished in a very simple manner. On the EAST INDIAN, therefore, there will be two telegraph logs, one a continuous record showing every order transmitted from the bridge and the other a booked log of the orders as received in the engine room. Nobody would ever dispute the desirability of having the two records, but it needed a Ford engineer to realize that a record could be made on the bridge without involving extra labor.

There is another detail on the EAST INDIAN worthy of notice as a Ford inspiration, but which must be regarded as an experiment. A Dodge speed boat capable of 30 or 35 miles an hour in smooth water has been placed aboard with the idea that it may save many valuable hours in the course of the year. If the Captain has to go ashore for orders, or again for instance, if the vessel is loaded and waiting for her clearance papers, the use of the speed boat may save a lot of time. In comparison with the cost of demurrage the price of a little speed boat is relatively small, and it may very well be found in the case of the EAST INDIAN that the expense will be worth while.

At the present time the Ford Motor Co. has no marine department covering the operation of the ONEIDA, ONONDAGA and EAST INDIAN. These three vessels come under the orders of the Traffic Department. When they are in coastwise service they receive their orders through different Ford branches. When they are in foreign trade they get their orders from the Foreign Department. The Ford organization is used to the greatest possible extent. For instance, when the EAST INDIAN loaded last month at Hoboken, N. J., the cargo was stowed entirely by gangs from the Kearny (N. J.) assembly plant. For the two trips which the EAST INDIAN made between New Orleans and Tampa a month earlier she was loaded in New Orleans by gangs from the New Orleans assembly plant. When the ship reaches port she sends her laundry to the nearest Ford plant. As far as possible all work is done by the Ford organization on a carefully studied plan.

# Tax on Foreign Built Yachts

LARGELY due to the representations made by Henry R. Sutphen, president of the National Association of Boat and Engine Builders, vice-president of the Submarine Boat Corporation, New London Ship & Engine Co., Electric Launch Co. and other companies, the new Revenue Act passed by Congress and signed by the President, contains a provision for taxing foreign built pleasure boats. The clauses relating thereto read as follow:—

"Sec. 702. On and after July 1, 1926, and thereafter on July 1 in each year, and also at the time of the original purchase of a new yacht or other boat by a user, if on any other date than July 1, there shall be levied, assessed, collected, and paid, in lieu of the tax imposed by Section 703 of the Revenue Act of 1924, upon the use of yachts, pleasure boats, power boats, sailing boats, and motor boats with fixed engines, if foreign built and if of over 5 net tons and over 32 ft. in length, not used exclusively for trade, fishing, or national defense, a special excise tax to be based on each such yacht or other boat, at rates as follows—Yachts, pleasure boats, power boats, motor boats with fixed engines, and sailing boats, of over 5 net tons, length over 32 ft. and not over 50 ft., $2 for each foot; length over 50 ft. and not over 100 ft., $4 for each foot; length over 100 ft., $8 for each foot.

"In determining the length of such yachts, pleasure boats, power boats, motor boats with fixed engines, and sailing boats, the measurement of overall length shall govern.

"In the case of a tax imposed at the time of the original purchase of a new yacht or boat on any other date than July 1, the amount to be paid shall be the same number of twelfths of the amount of the tax as the number of calendar months (including the month of sale) remaining prior to the following July 1.

"This section shall not apply to any yacht or other boat (1) which is used without profit by any benevolent, charitable, or religious organization, exclusively for furnishing, aid, comfort, or relief to seamen, or (2) which was owned on January 1, 1926, by a citizen of the United States or by a domestic partnership or corporation."

# East Indian's General Characteristics

## Ford Motor Company's New Motorship Is Largest Vessel yet Converted from Steam to Motorpower

BECAUSE she is the largest vessel yet converted from steam to Diesel power, because her oil engines are powerful enough to drive her with a capacity cargo at a sea speed of about 13½ knots, because her conversion was made with a minimum of structural alterations and because she has been equipped throughout with the most modern marine equipment, the EAST INDIAN possesses unusual interest, apart from those features which characterize her as a Ford Motor Company's vessel.

She was completed as a twin-screw steamer in 1918 at one of the Japanese shipyards and purchased by the Shipping Board. She was one of the largest vessels built for the American Government in Japan and of about the same design as the EASTERN TRADER and the EASTERN MERCHANT, now known as the HORACE LUCKENBACH and the ROBERT LUCKENBACH respectively. She herself was originally known as the BEIKOKU MARU, but has carried the name EAST INDIAN ever since she has flown the American flag. Originally a coal burner, she was equipped with Scotch boilers and triple expansion engines of 4200 i.hp. About this time last year when she was purchased by the Ford Motor Co. she was not in operation.

For the conversion that was planned she seems to have been an excellent choice. The main Diesel engine and auxiliary equipment have fitted into the original machinery space, and the shafting and propellers have not been changed except that the shafts were lifted nearly 1 in. at the forward end and the wheel blades set at a different pitch.

A shelter deck vessel with five cargo holds and 'tween deck spaces, with double bottom tanks for oil and water, since her conversion to motor power she has gained cargo space through the addition of a deep tank which was formerly the cross bunker. For handling the cargo in and out of this newly added space electric winches have been added. In all other respects the former cargo handling appliances have been retained, consisting of eight 6-ton booms on the masts and ten 3-ton booms on the king posts, all served by steam winches.

By reason of the fact that she was originally built with double bottom tanks to carry either fuel oil or water ballast the conversion of the vessel from a coal burner to a motorship entailed no expenditure for fuel tanks. She can carry about 7100 bbl. of fuel oil and uses the former feed tanks, No. 1 double-bottom tank and the peak tanks for her fresh water supply, a total of over 300 tons.

The chief alterations made during the conversion by the Sun Shipbuilding & Drydock Co., at Chester, Pa., apart from those in the machinery space, affected the living quarters and the navigating equipment. These various alterations are described in detail in succeeding articles.

### Principal Characteristics of M.S. East Indian

| | |
|---|---|
| Length, o. a. | 461 ft. 0 in. |
| Length, b. p. | 445 ft. 0 in. |
| Registered breadth | 58 ft. 0 in. |
| Depth of hold | 29 ft. 0 in. |
| Molded depth to shelter deck | 40 ft. 0 in. |
| Gross register | 8159 tons. |
| Net register | 5160 tons. |
| Deadweight capacity | 11,200 tons. |
| Draft, loaded | 28 ft. 6½ in. |
| Cargo capacity | 583,657 cu. ft. |
| Main engines (2) | 5000 s.hp. |
| Sea speed, with Ford capacity cargo | 13½ knots. |

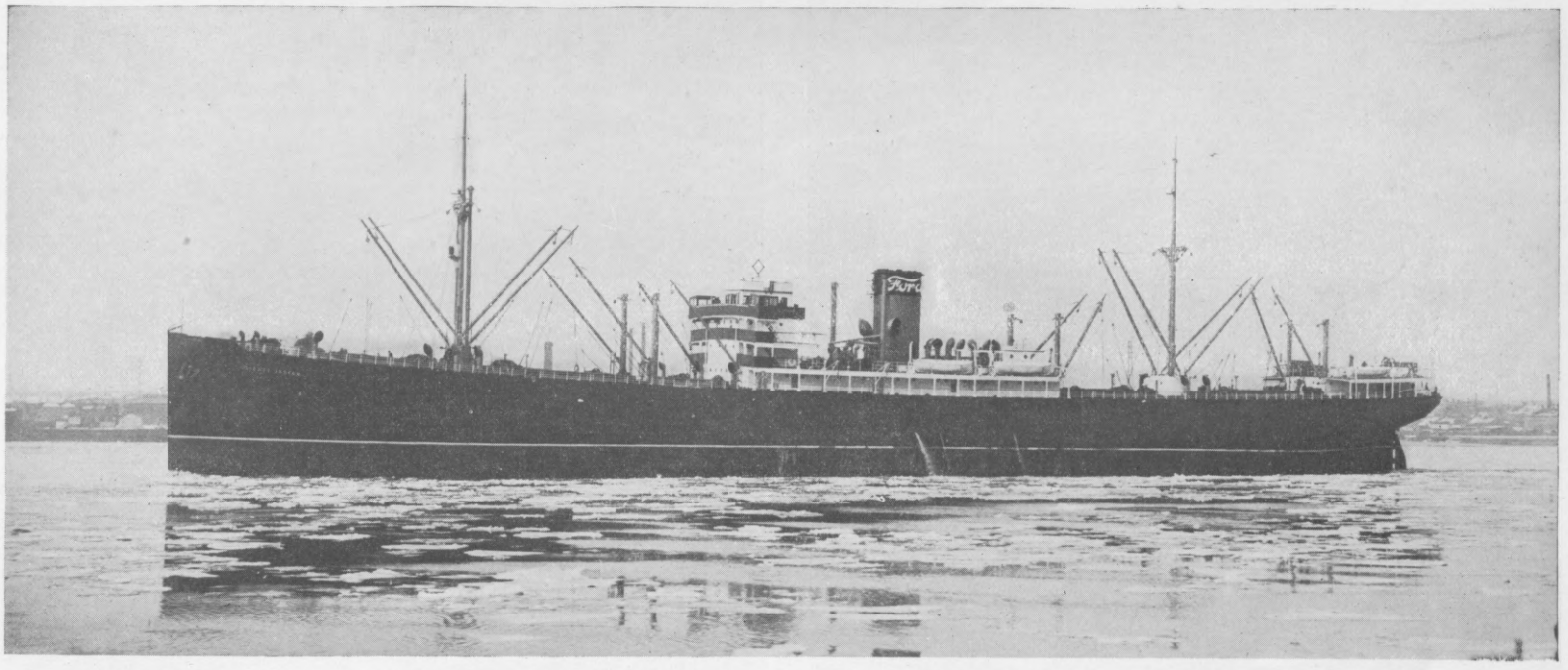
It will suffice to point out here that the conversion has been relatively economical. Although the Ford Motor Co. has very plainly desired to equip the vessel efficiently, it has also very clearly shown a characteristic thrift. One of the most noticeable examples is in the machinery power, which is sufficient to drive the vessel at 13½ knots fully loaded with Ford cargo, but one should note that Ford shipments on account of their bulk will not load the vessel down to her marks when the holds are full, and the vessel does not therefore require her full power to drive her at a sea speed of 13½ knots.. When she cleared from New York last month with holds full, she was drawing about 8 ft. less than her designed draft. Of course, in the event of her obtaining a full homeward cargo that would utilize her deadweight capacity to the limit she would make in excess of 12 knots.

That the vessel is not to be used exclusively for ocean voyages was demonstrated by her first loadings. On Feb. 19 last she cleared from New York with a capacity cargo of Ford shipments for Trieste, Barcelona, Copenhagen, Rotterdam and Antwerp and will not return to American waters until about the end of April. It is her maiden transatlantic passage as a motorship, but before loading at New York she made a voyage to the Gulf and two round trips between Gulf ports.

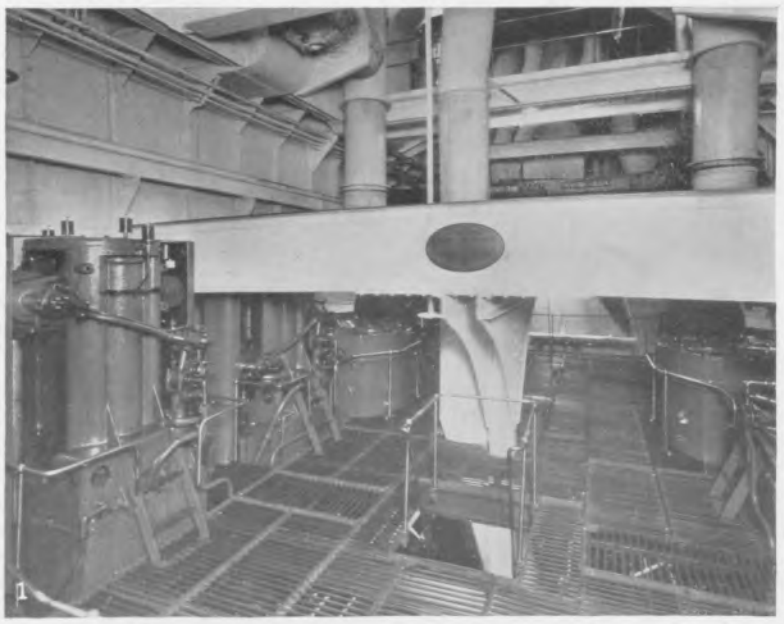
Her contract trials were run on Jan. 15 on her way down the Delaware River from the Sun yard at Chester. She was carrying a cargo of Ford cars and parts from Philadelphia for Tampa, Fla.

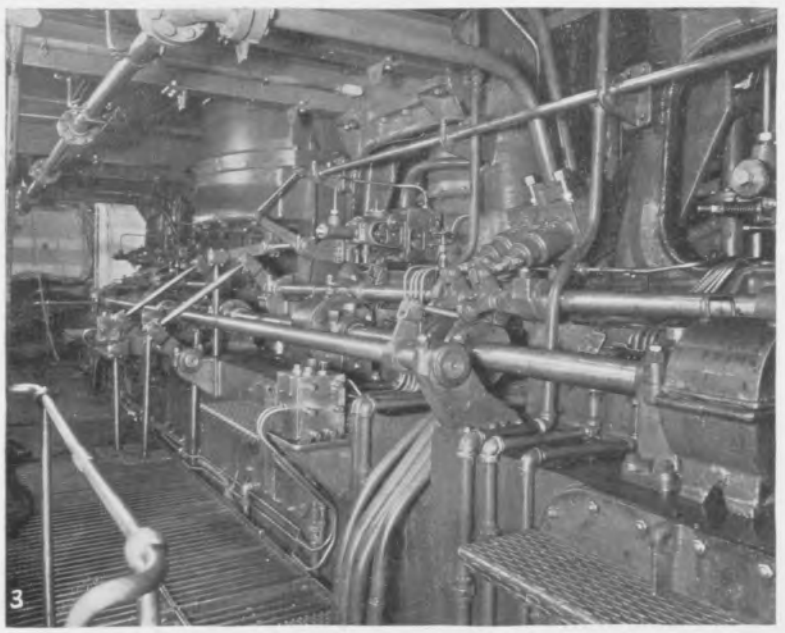
On the passage south she made a speed of 12.2 knots with the main engines turning at the low average of 77½ r.p.m. and consuming only about 12½ tons of oil per day. One auxiliary engine was running, burning about 50 lb. of fuel per hour, and boiler steam accounted for about 1½ tons

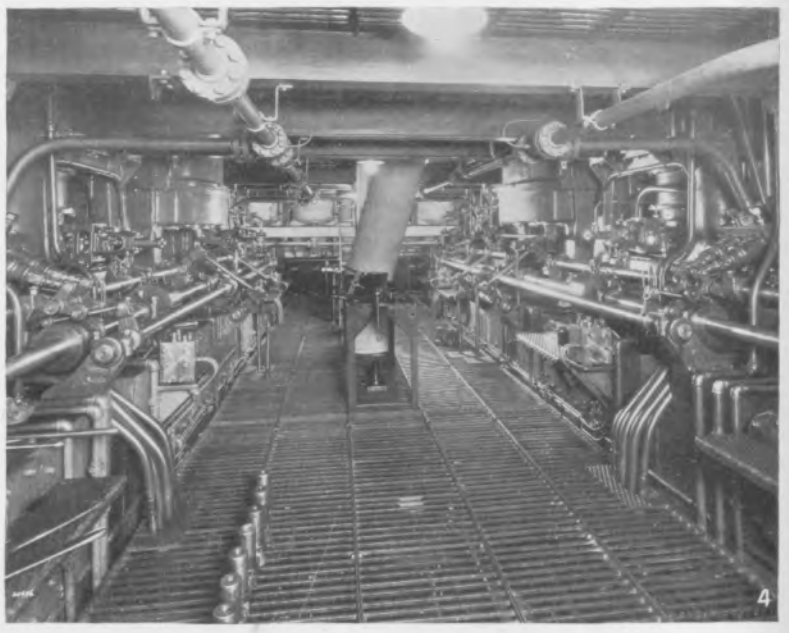
(*Continued on page* 198)

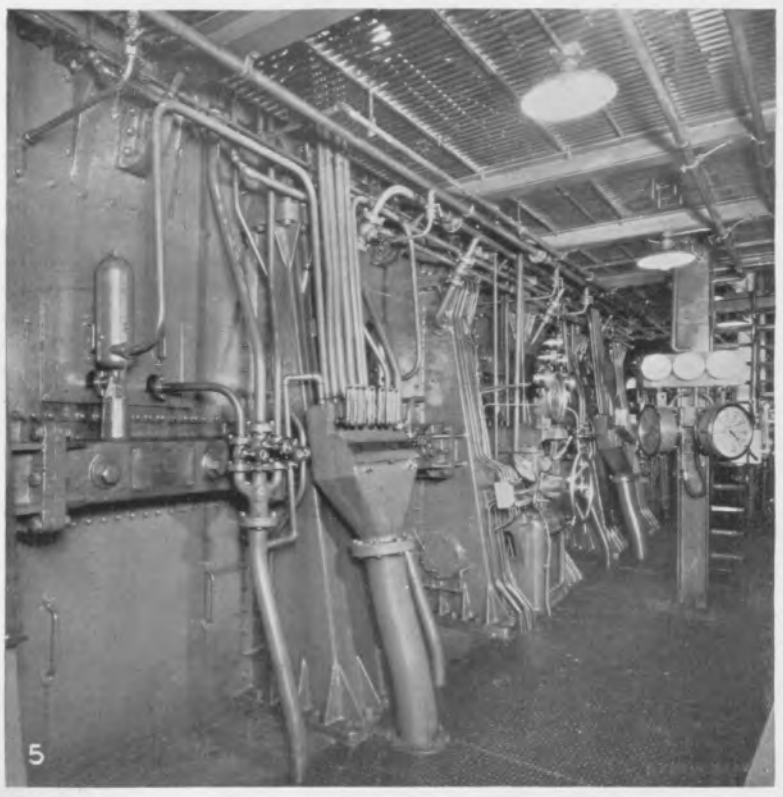


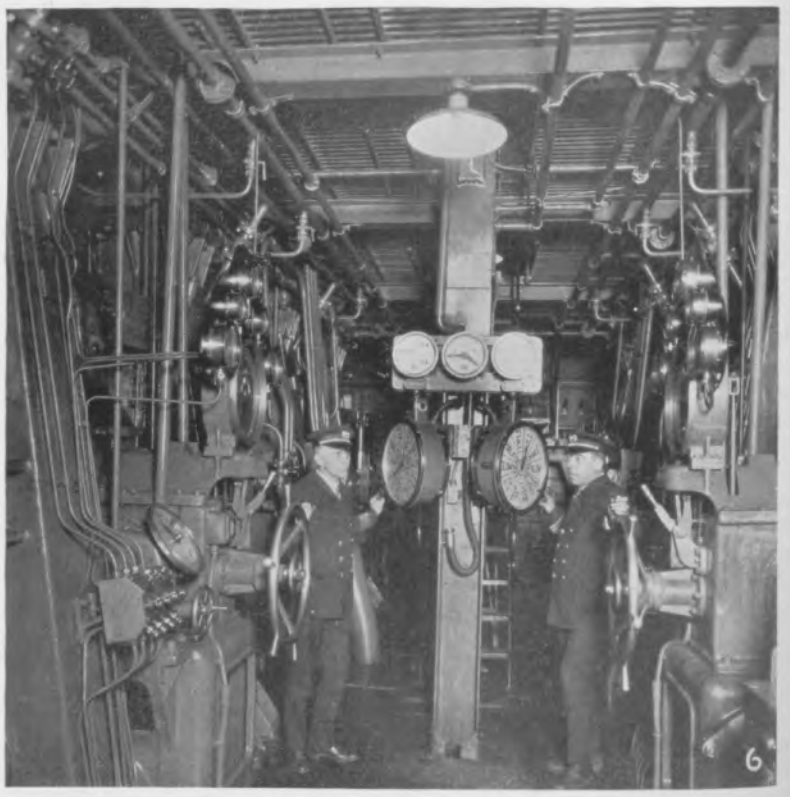
*East Indian, the new Ford motorvessel, is of about the same size as the Horace Luckenbach and Robert Luckenbach*











1 *and* 2. *Views of East Indian's engines, on the top grating.* 3. *Inboard camshaft and valve gear of starboard engine.* 4. *On the second grating, looking aft.* 5 *and* 6. *Control stands*

# East Indian's Main Engine Installation

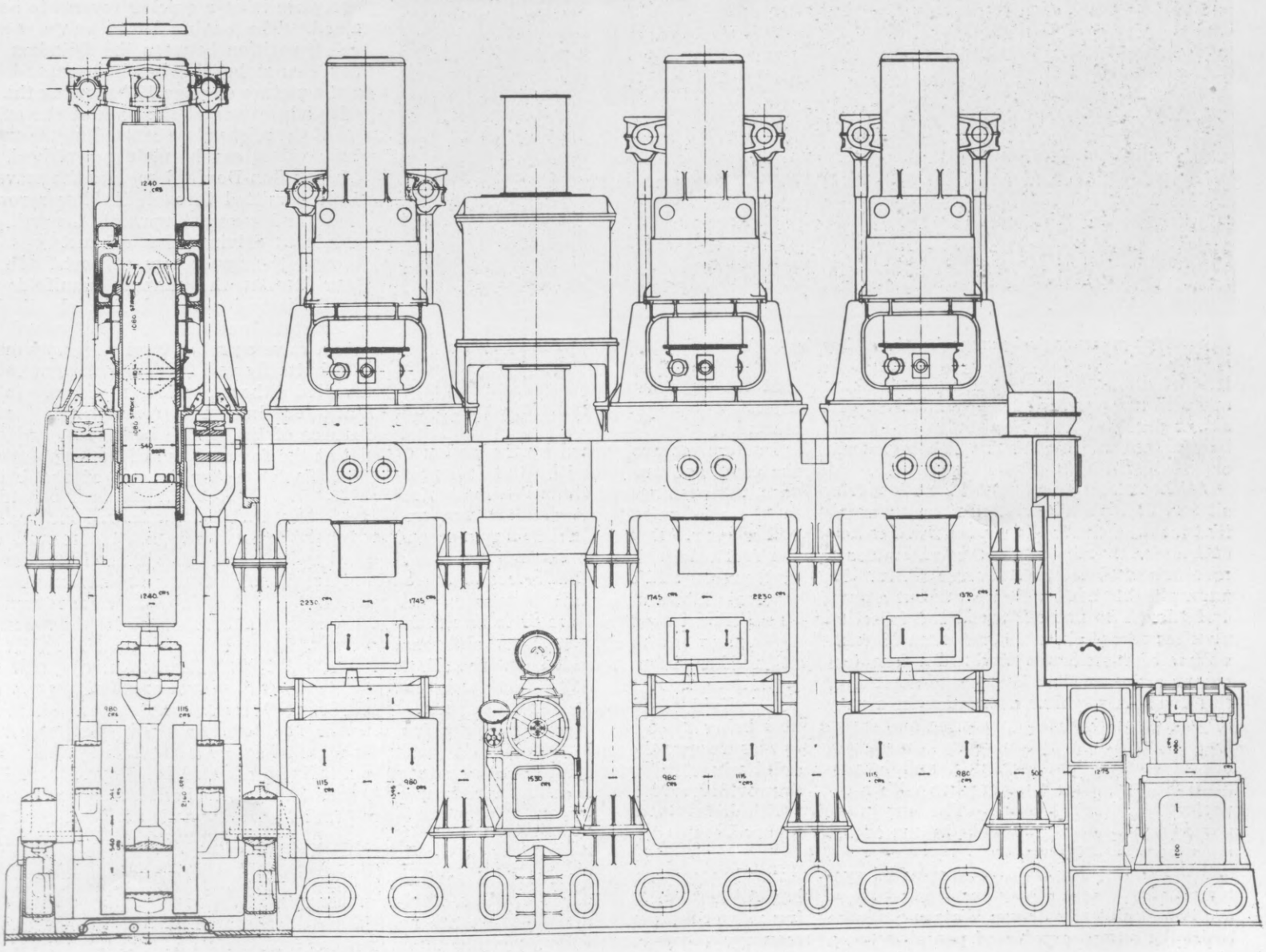
## Two Engines of 5000 s.hp. Aggregate at 95 r.p.m. Have Replaced Former Steam Machinery

WHEN the selection of machinery had to be made for the EAST INDIAN the Ford Motor Co. had already had experience with its two big ore carriers on the Great Lakes, in both of which Sun-Doxford engines had been installed and were giving every satisfaction. The same type of engine was therefore selected for the EAST INDIAN. The engines are smaller, but turn at a slightly higher speed. The question of power and speed were largely settled by the desire to use the original shafting and propellers.

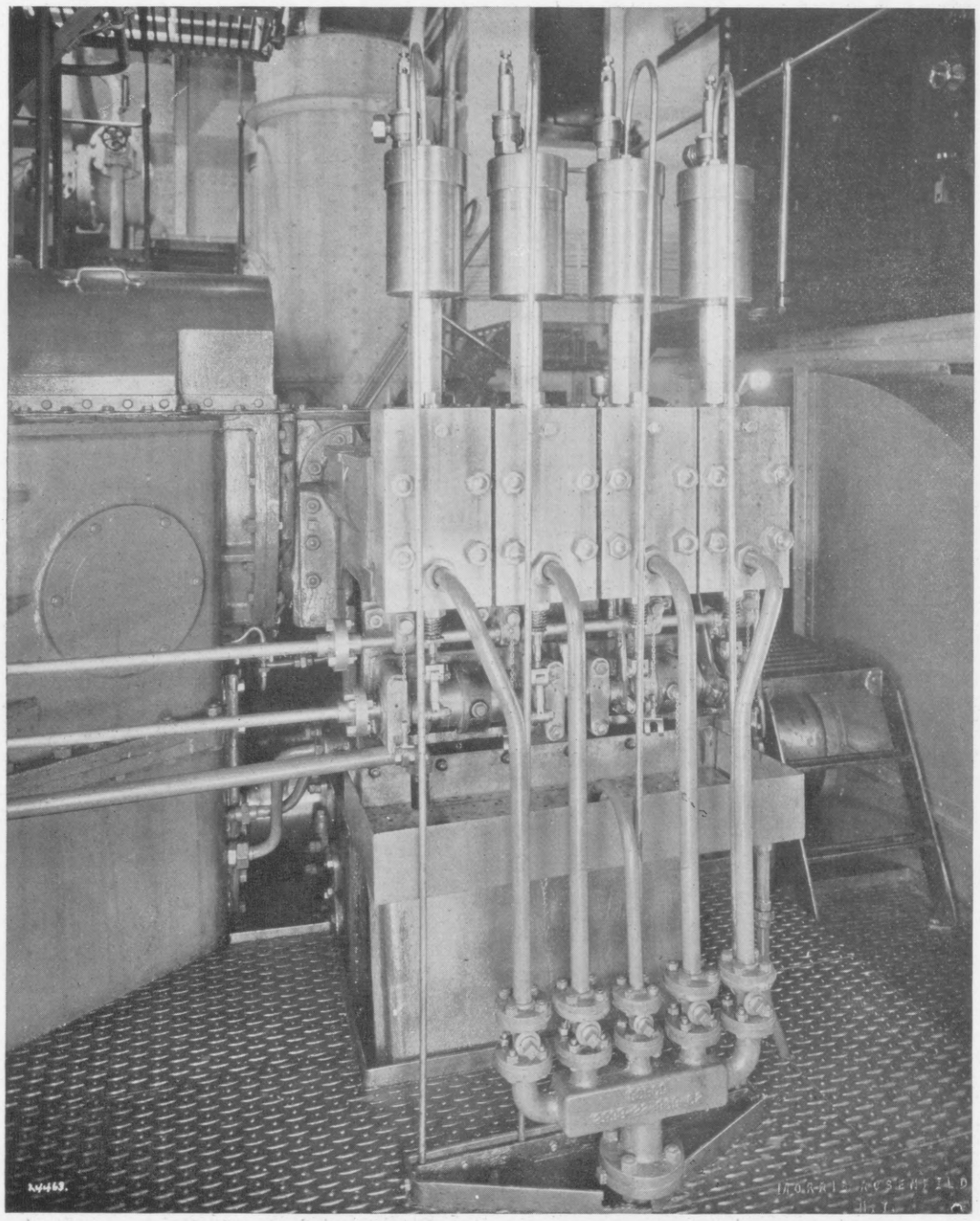
The EAST INDIAN'S engines have four power cylinders of 21.26 in. diameter and a total stroke of 85.04 in., with a scavenge pump direct-connected to the crankshaft in the middle of the engine. These engines at 95 r.p.m develop 2500 s.hp. each. In contrasting them with the Sun-Doxford sets in the BENSON FORD and HENRY FORD II, which have a cylinder diameter of 23.62 in. and a combined piston stroke of 91.34 in., it must be remembered that the latter, which develop 3000 s.hp. at 85 r.p.m., do not drive the scavenge pumps, but are served by electrically driven turbo blowers. The scavenge pump arrangement on the EAST INDIAN'S engines is the same as on the CHALLENGER'S engine which has four cylinders of 22.83 in. diameter with a combined piston stroke of 91.34 in. and which develops 2500 s.hp. at 72 r.p.m.

EAST INDIAN'S engines follow the usual Sun-Doxford design, operating on the 2-cycle system with opposed pistons, each upper piston driving through twin rod mechanisms to twin cranks which are at 180 deg. to the center crank, on which the drive from the lower piston is taken. Actually these engines do not belong to the Diesel class, being characterized by a much lower compression. On the other hand, they are not surface ignition engines. They seem to belong to a distinct class of their own. The compression pressure is about 300 lb. per sq. in., but the jacket walls and piston surfaces are kept at a slightly higher temperature than in the usual Diesel engine, the combination of lower compression and higher wall temperatures producing a result equivalent to the 500 lb. compression and lower wall temperatures of the real Diesel. The true nature of the combustion in the Doxford type engine does not seem to have been ever described by the Doxford firm or its licensees in an exhaustive manner. The indicator cards show a feature of combustion at constant volume, but also show combustion partly at constant pressure. That the system works well is shown by the records of the Sun-built engines in this country and of the Doxford engines abroad. Engineers of the HENRY FORD II, for instance, have asserted to us that no steamer on the Great Lakes has ever made such a good showing as their vessel has.

Because of the higher cooling water temperatures used in the Sun-Doxford engines, namely, about 130 deg. F. into the cylinder and about 160 deg. F. at the discharge, distilled water is used. This distilled water is circulated through a closed system, being passed after discharge from the engine through a cooler to reduce its temperature before circulating again to the engine. There are two make-up tanks holding 8



*Elevation and section of the 2500 s.hp. opposed piston engines of the converted vessel East Indian, owned by the Ford Motor Co.*



*High pressure fuel pumps for the airless fuel injection in the East Indian's engines*

tons of distilled water, and an evaporator and still are provided for replenishing. In actual practice, however, the make-up can be obtained more easily by bleeding steam out of the boiler.

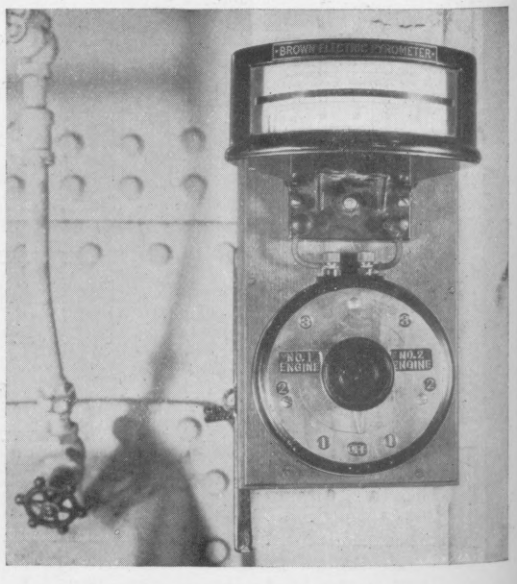
Airless injection of fuel is employed on all Doxford type engines. The fuel is atomized into the combustion space through two diametrically opposed fuel valves under a pressure of about 7000 lb. per sq. in. To maintain this high pressure without a pressure drop during the period of injection requires powerful pumps and a considerable volume of fuel in the lines. The four fuel pumps are geared to the engine abreast of the thrust block, where they are in a very accessible position for inspection and maintenance. Each pump chamber is machined out of a solid block of steel and is surmounted by a pressure chamber with a capacity of about 1 pint. The group of pumps is shown very plainly in one of the accompanying illustrations.

For priming the high pressure fuel systems before the engines are started there are two electrically driven Watson-Stillman hydraulic pumps capable of pumping up to 6000 lb. per sq. in. Their use enables the pressure to be built up in the fuel lines so that the regular fuel pumps can begin to inject as soon as the main engines are started.

Fuel valves are opened by the action of the cams and are closed by the fuel pressure, the opening and timing being subject to the mechanical control of a cam and rocker gear. Between the fuel pumps and the fuel valves there is on each cylinder a high pressure filtering device consisting of duplicate filters with a cut-off valve on each filter. Formerly this valve cut off both the fuel valves on the cylinder. An additional fitting has been provided on the EAST INDIAN to permit each fuel valve to be cut out individually, valves for this purpose now being fitted in the high pressure fuel bottles close to the fuel valves. Under each point where fuel may possibly drip, a tray is provided with a pipe leading to a hopper which drains into a sump out of which it is pumped each watch.

In addition to the duplicate fuel valves on each cylinder the Sun-Doxford engines have hitherto been fitted only with a starting valve and a relief valve—there are no scavenge valves because the scavenge air is admitted through ports in the cylinder. On the EAST INDIAN'S engines, however, another valve has been fitted to each cylinder in connection with what is termed the engine brake. This device was added to the CHALLENGER'S engine after that vessel was in commission and on account of its usefulness was later order for the EAST INDIAN'S engines. All that this engine brake accomplishes is to admit the compressed air from one cylinder near inner dead center to the adjoining cylinder which is correspondingly near outward dead center. To time this exchange of pressures between adjoining cylinders there is a pilot valve operated from the back camshaft of the engine. When the pilot valve is opened by its cam it admits air to the brake valves causing them to open and to provide intercommunication between the two cylinders through the medium of a pipe connection between the two valves. When the pilot valve drops off its cam the engine brake valves are automatically closed. There is one pilot valve for each pair of cylinders and an engine brake valve on each cylinder. Connection is made between the two brake valves on the forward cylinders and a similar connection between the two brake valves on the after cylinders, and both pairs operate simultaneously. It is stated that when the order to reverse is received in the engine room the use of the engine brake, after the fuel has been cut off enables the engines to be stopped much more quickly than is the usual practice, thus permitting a quicker reverse to be obtained. The engine brake valves are in such a position between the cylinders that they cannot be clearly photographed, but in the picture on page 197 showing the cylinder lubricators at the back of the engine one of the pilot valves controlling the engine brake valves can be plainly perceived.

In the Sun-Doxford engines the scavenge air is admitted through the lower row of ports and sweeps upward through the cylinders, driving the exhaust gas out through the upper row of ports. In the EAST INDIAN the exhaust manifolds are heavily lagged with asbestos, sheathed in sheet steel, and led at the forward end into a valve chamber from which, by means of a butterfly valve, the exhaust gas can be diverted either to a Maxim silencer in the stack or into the corresponding wing furnace of the Scotch boiler mounted on a flat at the forward end of the engine room. This Scotch boiler is one of the boilers

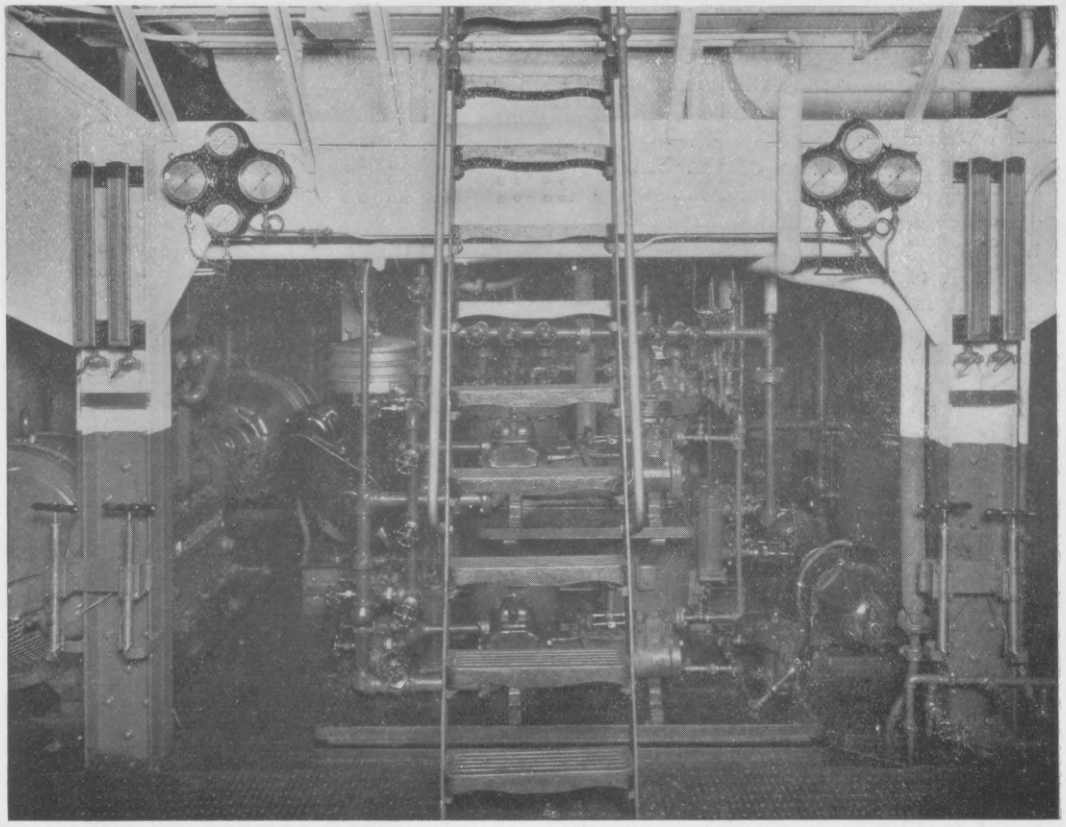



*Pyrometer for main engine exhausts*

originally fitted in the vessel, but its location has been changed.

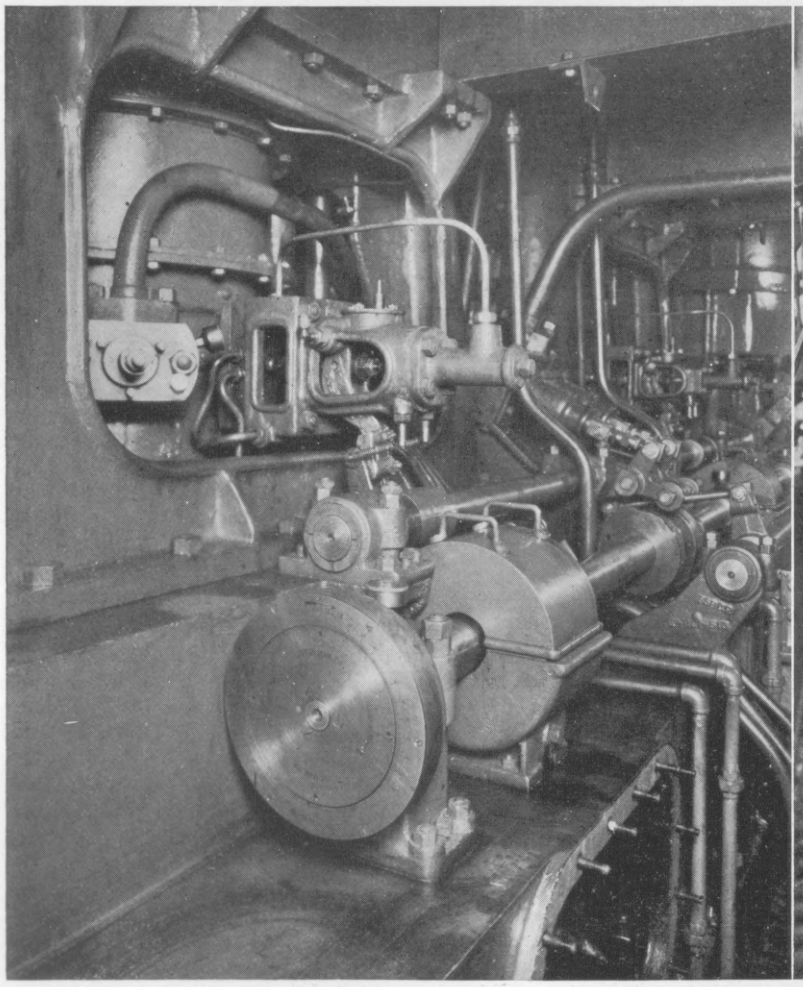
With the two wing furnaces heated by the exhaust gases from the main engine it is expected that a saving of boiler fuel will be effected. During the short period of the EAST INDIAN'S coastwise operation prior to the departure of the vessel to Mediterranean ports no gainful experience was obtained of the use of the waste heat in the boiler, because the pulsations of the exhaust caused leakage at the front flue doors. While the ship was in New York steps were taken to make these flue doors tight against the pulsating gases. The center furnace remains oil fired. At sea there is no use for steam other than for the heating of the living quarters and occasionally for the evaporator. To assist in the compilation of data about the use of the waste heat from the main engine exhaust a pyrometer installation is provided, with elements not only at each cylinder exhaust, but also at the intake of the exhaust to the wing furnaces and at the outlet.

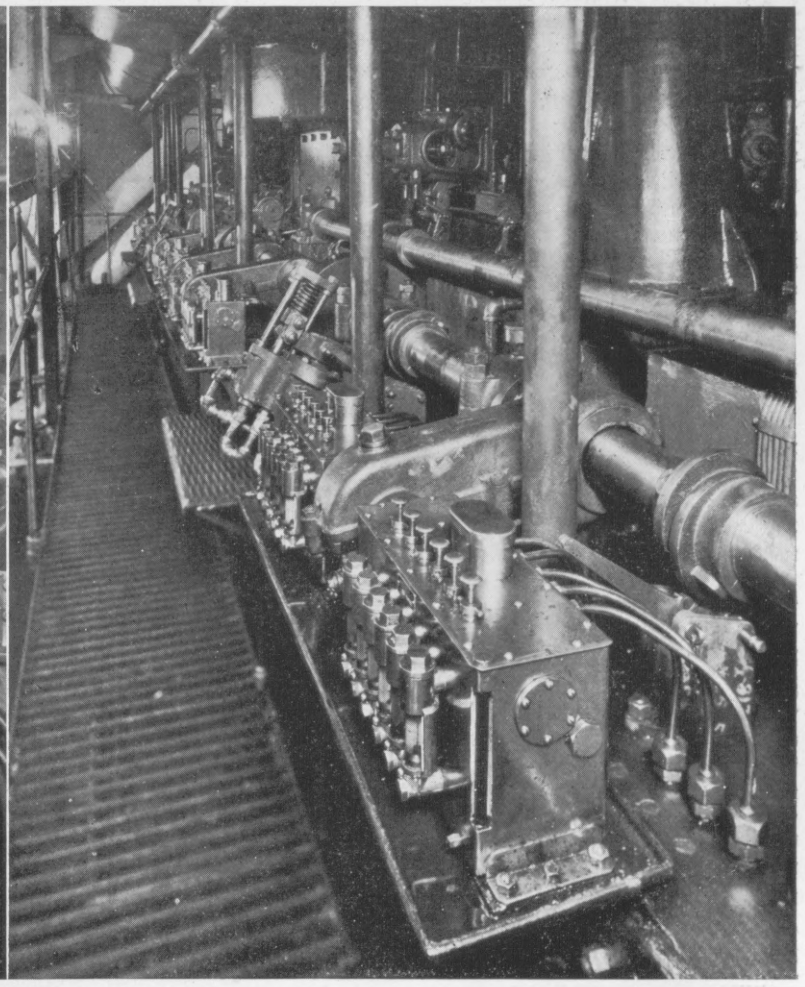
For the lubrication of the engines a forced feed system is used for the main bearings, crankpin bearings, crosshead guides and Kingsbury thrust block, the oil being supplied at a pressure of 30 lb. per sq. in. There are about 400 gal. of oil in the lubricating system of each engine and it circulates through oil coolers before passing back to the pressure pump. A De Laval centrifuge is installed for the purpose of purifying the oil for each engine. The supply is carried partly in tanks and partly in the engine columns. In the two engines there are a total of 16 columns, each containing about 100 gal. Across the after end of the engine room casing there are seven tanks, each containing about 510 gal., five with medium heavy oil and two with extra heavy oil. The total quantity of lubricating oil carried is therefore in excess of 5000 gal.



*Fuel centrifuges, transfer pumps, booster pumps, flanked by pneumercators on columns*

For cylinder lubrication Manzel oilers are used. There are six feeding points in the part of the cylinder swept by the upper piston and six points below for the lower piston. Each cylinder is therefore provided with two 6-point lubricators making a total of eight lubricators for the power cylinders on each engine, to which is added one lubricator for the scavenge air pump.



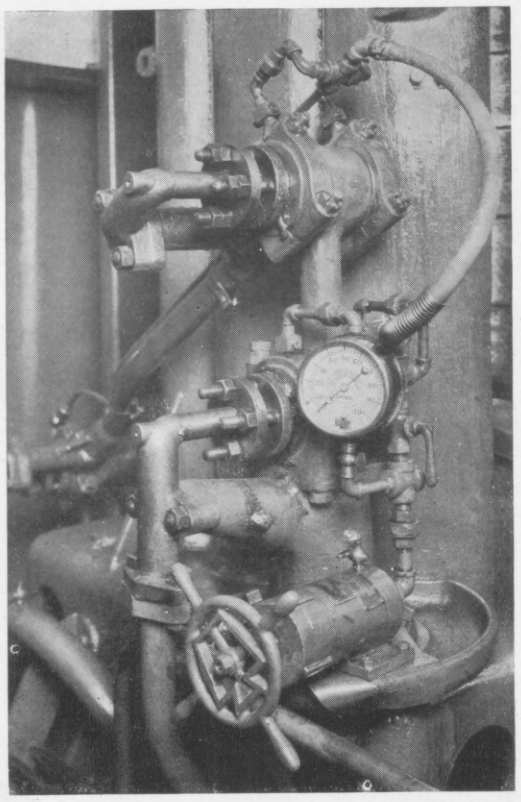


*At left, the valve timing dial on inboard camshaft and, at right, the cylinder lubricators driven from outboard camshaft*

The lubricators are arranged at the back of the engine at the level of the rear camshaft, from which they are driven by silent chains. Through the 18 lubricators on both engines about 1½ gal. of oil is used on each watch.

For the lubrication of the bearings of the cooling water pipes for the upper pistons Keystone manifold grease lubricators have now been fitted. They do not show in either of the pictures at the top of page 194, not having been installed when those pictures were taken, but a separate view of them is given on this page. The Keystone manifold lubricator consists of a grease barrel with a worm feed ram, by means of which the grease can be put under pressure. The gauge reads up to 100 lb. per sq. in., but a pressure of only 20 lb. per sq. in. is employed. From this barrel the grease is fed through a grease proof rubber hose to the bearings at both ends of the articulated waterpipes, there being five lubricating points in all. Owing to the fact that the water passing through the discharge pipe has a temperature of about 160 deg. F. a special grease has to be used. The use of this type of lubricator eliminates the spattering and dripping of oil inevitable with moving parts of this sort when oil lubrication is employed.

Near the control stand are arranged all the fuel and water connections, together with the gauges and controls. A starting air pressure of about 600 lb. per sq. in. is used, the starting air being supplied by auxiliary electric compressors and stored in three tanks of 150 cu. ft. capacity each. One compressor is sufficient to keep them replenished when the main engines are being maneuvered. The water discharges are all supplied with thermometers at the lower end where they empty into drain hoppers, and the valves on the water supply lines are right alongside, where they can be conveniently adjusted. The distilled water drains into two tanks between the engines, and the cross connection between them is generally kept open. From the control stand the Pneumercator gauges on the fuel day tanks are clearly visible. These tanks are at the forward end of the engine room on either side of the boiler and are provided with steam coils for heating the fuel. The fuel is centrifuged before it is pumped into the day tanks, two De Laval separators of the vapor-tight type being installed for this purpose. The fuel centrifuges, the fuel transfer pumps and Watson Stillman fuel booster pumps are grouped together at the forward end of the engine room in the middle line of the ship with the Pneumercator gauges mounted on the columns supporting the boiler flat. The engine room telegraphs are of a new Sperry pattern. When an order is rung down from the bridge a red light shows as long as the bell is ringing, and both bell and light are only switched off when the order is correctly repeated back to the bridge. Above the telegraph are the Sperry revolution indicators for port and starboard, with the so-called engine comparator between them. These Sperry revolution indicators are based upon the same electrical principle that is used in the Sperry gyro repeaters and have the same degree of accuracy. The electrical attachment on each engine is mounted on the forward end of one of the camshafts and counts only the ahead revolutions, being temporarily inoperative when the engine goes astern. The engine comparator has two pointers, one colored red for port and the other colored green for starboard, showing the direction of rotation of the respective engines and their relative speed. This device is more fully described in the article dealing with the navigating equipment of the EAST INDIAN.



*Grease manifold on water pipe bearings*

For assistance in handling heavy engine parts a 7-ton Shepard electric overhead crane is provided. To run it from end to end of the engine room, sections can be taken out of the scavenge suction pipes and air ventilator pipe, all of which lead downward from the top of the engine casing.

## East Indian's General Characteristics

(*Continued from page* 193)

per day. From Tampa she went on to New Orleans to unload the balance of her cargo consisting of about 1500 tons of automobile parts. Then she took aboard 558 cars from the New Orleans assembly plant of the Ford Motor Co. and returned to Tampa to discharge them. After returning light to New Orleans she took aboard another load of 545 machines for Tampa.

These three shipments to Florida enabled the company to overcome difficulties experienced this winter through the freig' embargo in force on the Florida railroads. In a period of less than two weeks the EAST INDIAN landed more than 1650 cars at Tampa, but inclement weather and port congestion were responsible for delay. Under favorable conditions the shipments should have been landed in quicker time. For instance, the second cargo at New Orleans was loaded in less than eight hours, whereas when she docked there on her first call she spent 51 hours unloading 1500 tons and taking aboard 558 Ford machines. She discharged at Tampa the second time in 17½ hours, whereas on her third visit she had to wait 48 hours to go alongside.

From Tampa the EAST INDIAN went north to New York at a speed of 14 knots with the engines indicating an average of 4096 hp. at an average of 82.6 r.p.m. From the Sea Buoy off Tampa to the Scotland Lightship, a period of 4 days 3 hours 22 min., the consumption averaged for the main engines about 13.1 tons per day, for the auxiliary engine about ¾ ton per day and for the boiler about 0.85 ton per day.

In New York she was sent to an uncovered pier so that her cargo could be taken aboard directly from the railroad cars without intermediate handling.

## Swedish Motorliner Loan

In support of its application to the Swedish government for a loan of one-half of the cost of a sister vessel to the GRIPSHOLM the Swedish American Line presented some interesting data and statements. The cost of the GRIPSHOLM was asserted to have been $3,752,000, but it is estimated that a sister ship today would cost about $1,000,000 more. The Line proposes to build the vessel at the Götaverken, provided a price can be obtained from that firm not too greatly in excess of foreign quotations. The Line seeks a loan of $2,150,000 from the Swedish government and proposes to obtain the balance of the cost partly out of the earnings of the Line during the period of construction and partly by shipyard credit.

The Swedish American Line reports that the number of passengers carried in 1924 was 22,832, which increased to 24,362 passengers in 1925. In the first year 7,300 passengers were carried to the United State for entry under the Swedish quota, but this number fell to 6,632 in 1925. The statement is made that any further restriction of immigration will render all the more necessary vessels of a high standard to attract tourists and passengers to pay for speed and comfort.

GRIPSHOLM is credited with an average consumption of 65 tons of oil per day, compared with 93 tons on the DROTTNINGHOLM and 105 tons on the STOCKHOLM, the two latter being steamers of smaller size.

## East Asiatic Liner

A new vessel, the DANMARK, has recently been added by the East Asiatic Co. of Copenhagen to its large fleet of motorvessels, which is now brought up to an aggregate of about 200,000 tons d.w.c. motor-driven. The latest ship measures 460 ft. h.p. by 59 ft. 4½ in. molded breadth and 38 ft. 4½ in. molded depth to the upper deck, the gross tonnage being 8,391 tons. On a draft of 28 ft. 10 in. she can carry 12,350 tons. Like all the East Asiatic Company's boats the DANMARK has accommodation for 12 passengers. A new feature in the living quarters for the passengers, officers and engineers amidships is the provision of large brass framed sliding windows instead of ports, and these are all fitted with screens.

Her propelling machinery consists of two 6-cylinder Burmeister & Wain single-acting engines of 5,400 i.hp. at 115 r.p.m. giving the vessel a sea speed of 12¾ knots. Three Diesel generator sets of 65 kw. each are provided for the supply of electric current.

# Auxiliary Machinery of East Indian

## Improved Electrical Practice and Full Provision of Spares for Electrical Machinery Are Outstanding Features

IN the auxiliary equipment of the EAST INDIAN'S engine room there are many interesting features. The most notable is the use of remote controls for all the electrically driven sets. It is not an innovation in the EAST INDIAN, having already been featured in the J. W. VAN DYKE. A new departure is, however, represented in the complete provision of spare armatures, about 20 of which are carried in racks at convenient locations in the engine room as near as possible to the points where they may possibly be needed. There is a spare armature for every size of generator and motor, including one even for the 150 kw. generators.

The switchboard also is considerably different from the type usually employed on shipboard, and follows the most up-to-date practice in power plants ashore. To the Sun Shipbuilding & Dry Dock Co. itself is due the credit of the design for the main switchboard, which was built by the Walker Switchboard Co. of Philadelphia. It is of the dead-front type with 11 panels, on which are mounted only the switch handles, pilot lights, instruments and rheostat handles. From the starboard side of the switchboard these panels in turn are as follows: 2 for the steam generators, 2 for the oil engine generators, 1 totalizing panel, 3 power distribution panels with 12 circuits, 2 motor generator panels and 1 lighting distribution panel. The four generator panels and two motor generator panels are provided with Ward Leonard rheostats and Weston ammeters.

On a separate frame at the rear of the switchboard is carried all the actual operating gear, consisting of switches, Cutter Co's circuit breakers and the rheostats, with ample space for the electrician to work in safety. Across the top of the switchboard, extending from end to end, is a screened reflector for illuminating the panels. The lights of this reflector and the more important lights in the engine room, such for instance as at the control stands of the main engines, at the boiler gauges, etc., are classified as emergency lights and are connected to 230 volts current on the generator side of the switchboard. In the event, therefore, of trouble on the generator panels of the switchboard, with consequent isolation of the lighting panel, there will be a few lights in the engine room so long as one of the generators is kept turning.

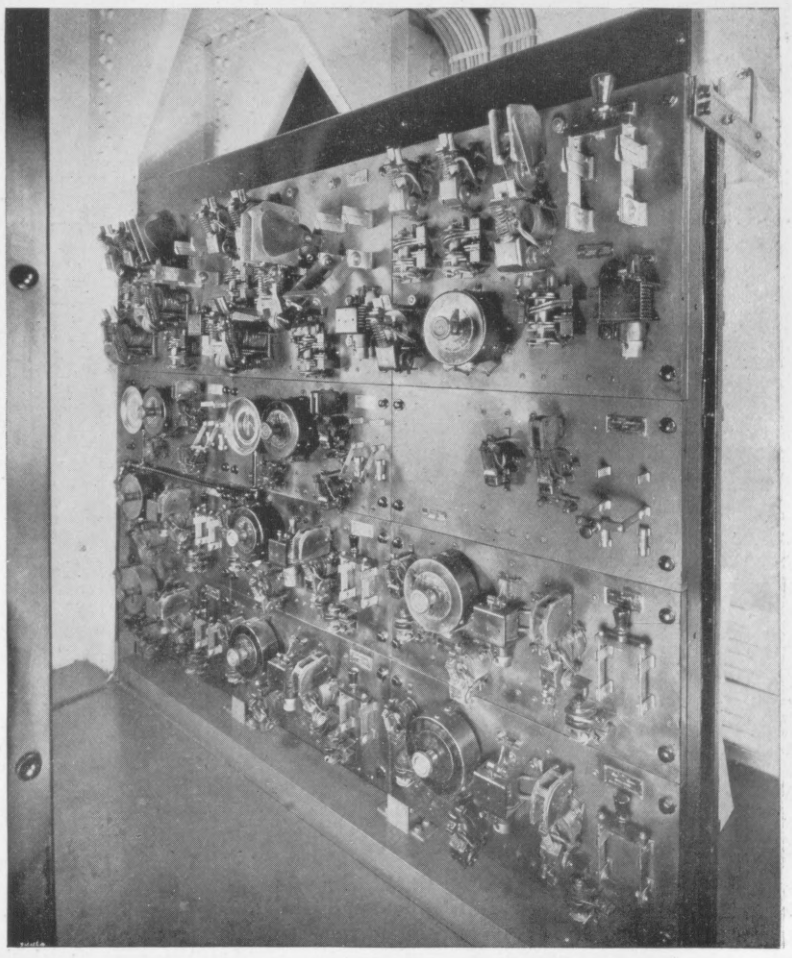
In the two wings of the switchboard flat and at right angles to the main switchboard there are two remote control switchboards for the electrical motors of the auxiliary engine room sets. These boards were designed and built by the Westinghouse Elec. & Mfg. Co. to eliminate the control panels generally scattered around the engine room near the different motors. The difference is that in the EAST INDIAN each motor is started by a push button mounted right on it, which energizes the circuit of its corresponding magnetic contactor or remote control on the switchboard, thus starting up the motor.

In this case, of course, the field rheostats and resistances are at the back of the board, and the speed of the motor can therefore only be varied at the board. In practice this is no inconvenience, because the motors are generally operated at a determined speed and the field rheostats are therefore adjusted to that speed. When the push button on the motor is pressed the motor runs right up to its regulated speed and stays there.

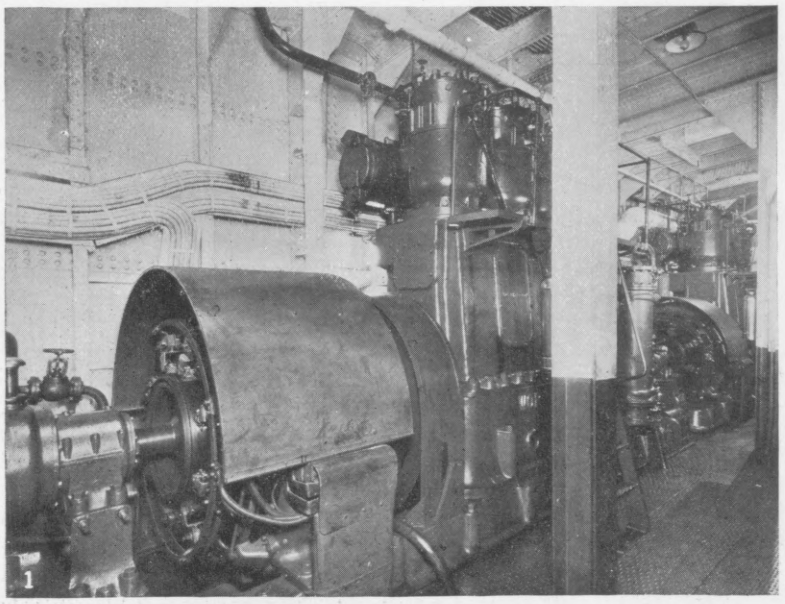
The big advantages of this arrangement are that the motor controls are centralized in a position where they can be protected from water drips or leaks and where they can be more easily attended to by the electrician when necessary. The only controls and resistances not mounted on either of the motor control switchboards are those for the jacking gears on the main engines, for which purpose 20 hp. motors turning at 850 r.p.m. are used.

Throughout the vessel armored cables are used, and this undoubtedly makes a better job than running ordinary cables through conduits.

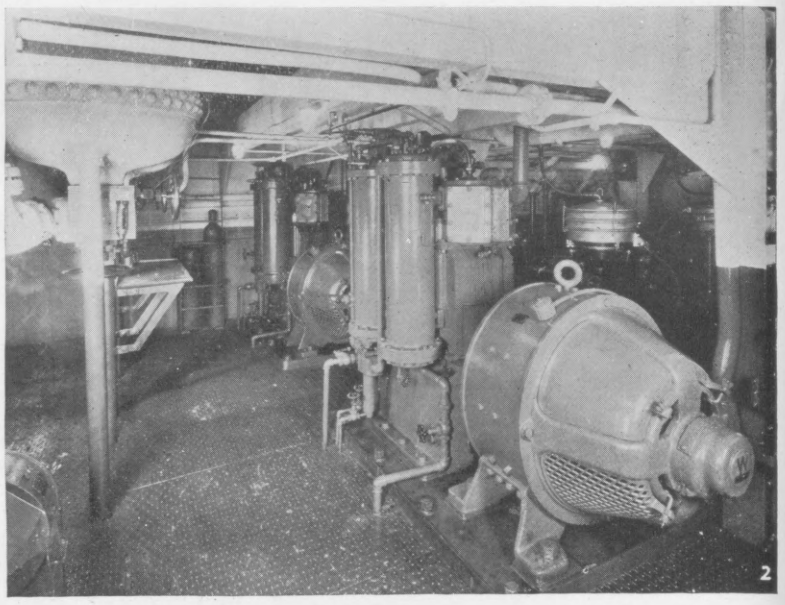
As the main source of electric power there are two oil engine generating sets of 150 kw. capacity each, driven by 3-cylinder Worthington 2-cycle airless-injection engines developing 225 b.hp. at 275 r.p.m. The generators are of Crocker-Wheeler build and of the d.c. type with



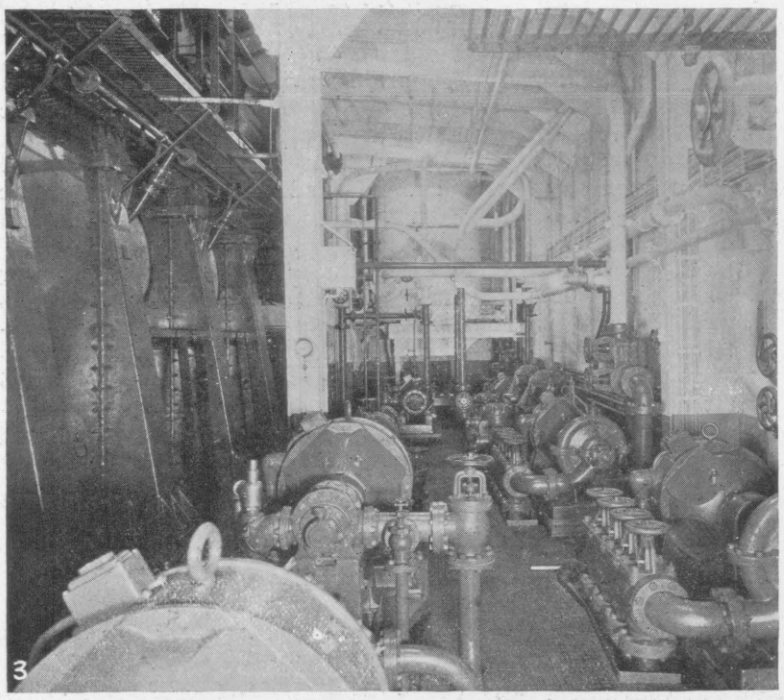
*At the left, East Indian's main switchboard—dead front type—and at th e right, one of the motor control switchboards*



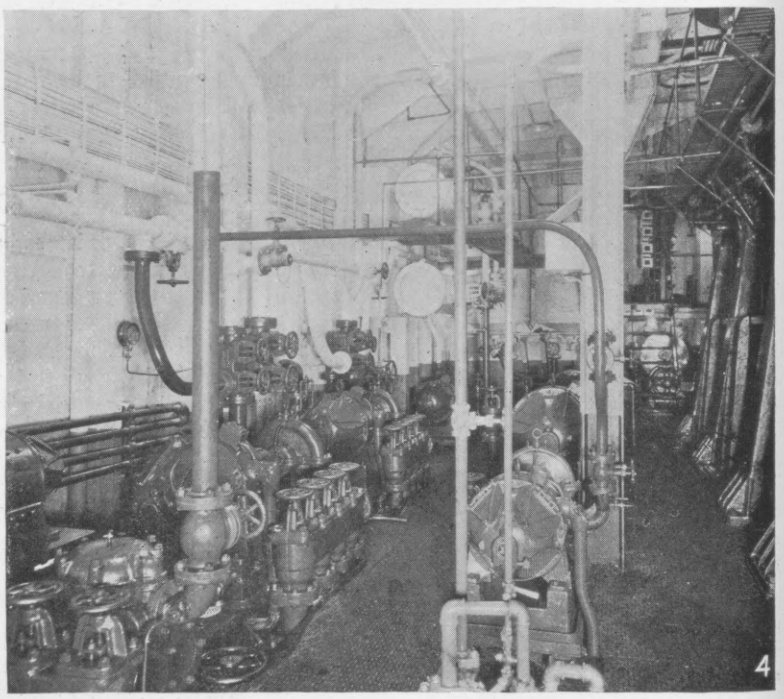
1. *Two Diesel generating sets of* 150 *kw. each are installed*



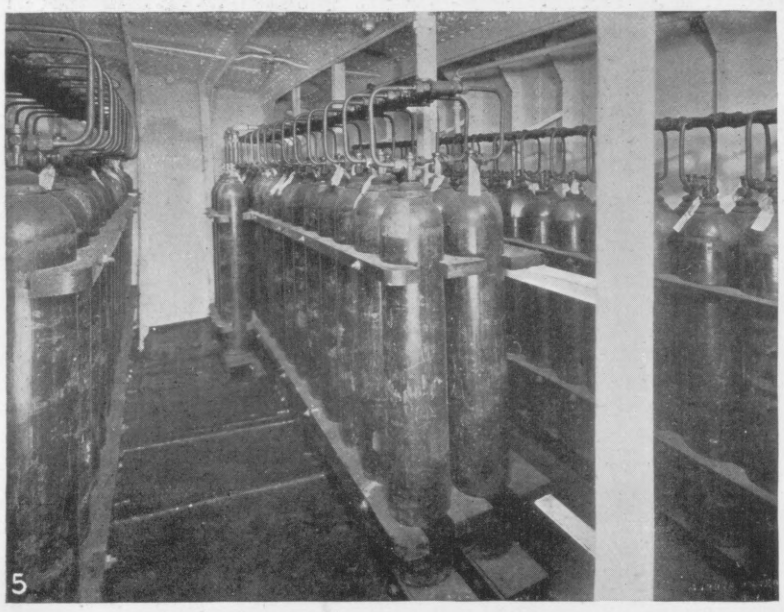
2. *Electric compressor sets for replenishing maneuvering air*



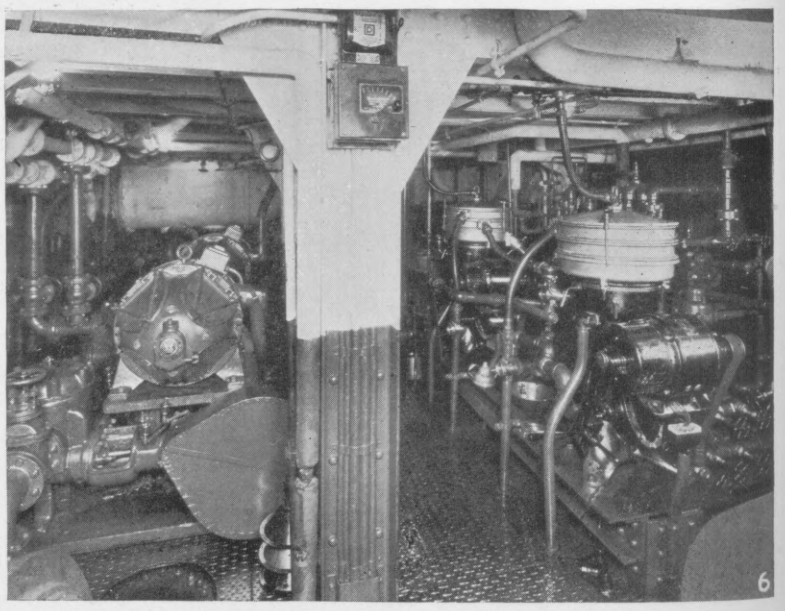
3. *Starboard wing in engine room, looking forward*



4. *Starboard wing in engine room, looking aft*



5. *Batteries of the Lux fire extinguishing system*



6. *Looking athwartships under the boiler flat*

heavy guards extending over them and over the commutators to protect them from water drip and as a safety measure. The flywheel between the generator and engine is also covered.

This type of Worthington engine, with cylinders of 15¼ in. diameter and a piston stroke of 16 in., is fitted with crossheads and utilizes the bottom ends of the cylinders as scavenge pumps. They operate on the Diesel principle with a modified Leissner type of fuel sprayer. Some of the earlier engines of this type were noisy, but no complaint of that sort can be made against the engines of the EAST INDIAN'S generating sets. The hammering noise of the fuel pumps has been completely suppressed by the use of new silent tappets, and a measure of the quiet running of these engines can be given by the statement that the most audible sounds are those of the water pump valves and of the gearing of the lubricating oil pumps. These engines are self-contained with their own circulating water pumps and lubrication pumps, the former being of the reciprocating type driven off the end of the generator shaft and the later a rotary type pump geared off the fuel pump shaft.

For priming the fuel lines before starting there is a small electrically driven pump independent of each engine, but adjacent to it. For starting the engines a pressure of 300 lb. per sq. in. is used, the supply being drawn from a separate starting air receiver, independent of the starting air tanks of the main engines which are at a higher pressure. The exhaust lines from these sets include about 4 ft. of flexible pipe near each engine and another section of the same sort of pipe in the stack. The rest of the exhaust lines is heavily lagged with asbestos, and they terminate in individual mufflers in the stack.

The two steam generator sets, which are of 15 kw. capacity, are installed merely because there is ample room for them on the starboard flat and they cost nothing, having been a part of the original steam equipment of the EAST INDIAN. About the only eventuality in which they could be used would be when the vessel goes into drydock or is taken out of service for a survey. Individually or together these two generators could not take care of the ice machines and of the lighting. One of the oil engine generator sets, therefore, has to be kept continually in operation. The power circuits use 230 volts. For the lighting current at 115 volts there are two 30 kw. Westinghouse motor generator sets turning at 1750 r.p.m.

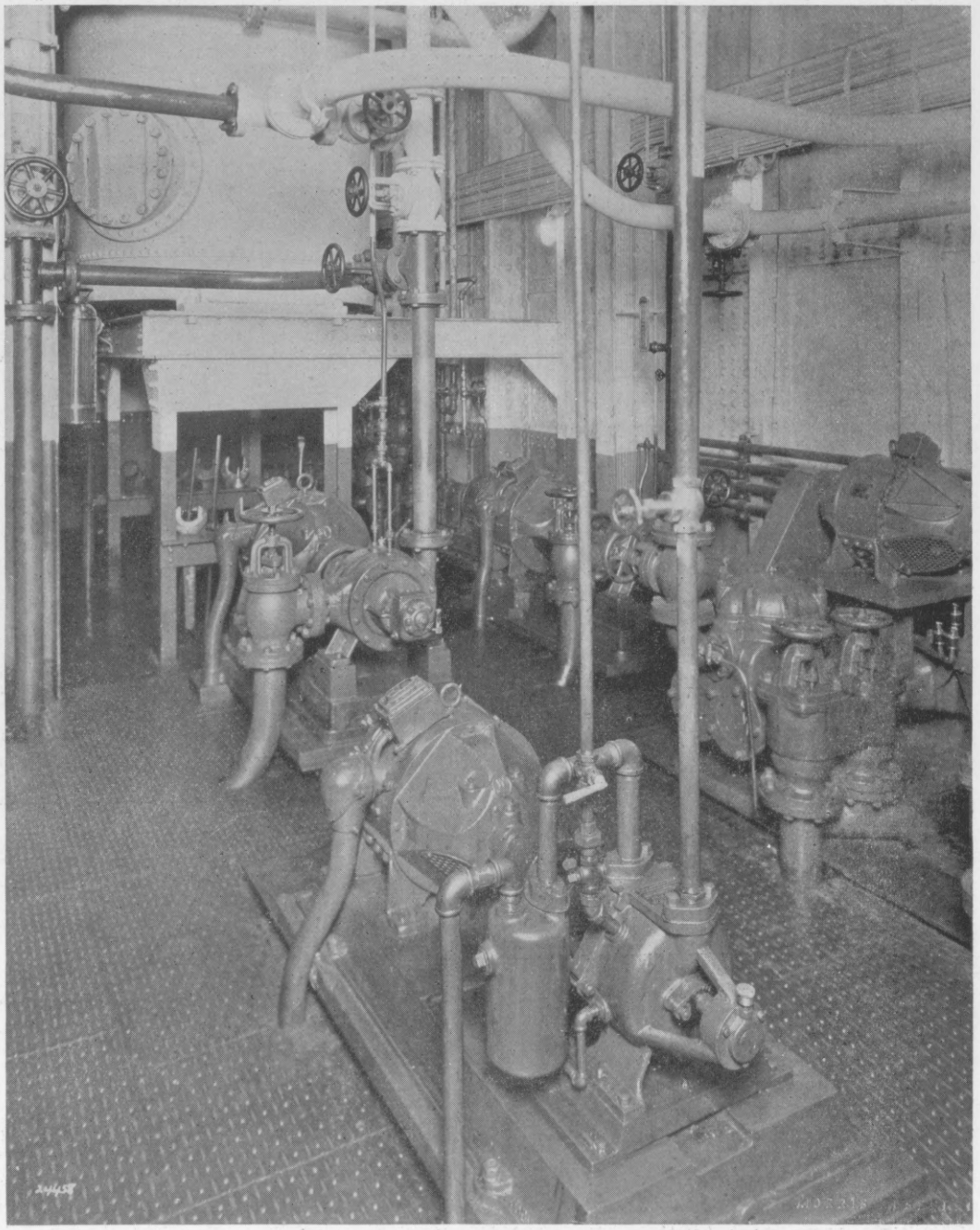
Practically all of the auxiliary pumps and other auxiliary equipment in the engine room, apart from the oil engine generator sets, is installed in the starboard wing or at the forward end of the engine room under the boiler flat. A full list of the pumps is given in a table on page 202. The motorpower indicated is for the rated capacity of the pumps and does not correspond with the Westinghouse motor ratings. The motors are rated by the Westinghouse firm at speeds that do not correspond in many cases with the rated pump speeds. The table shows the actual power taken from the motors at full pump capacity. Practically all the pumps were supplied by the Union Steam Pump Co. of Battle Creek, Mich. and are direct connected to Westinghouse motors. The exceptions are the two fuel booster pumps made by the Watson Stillman Co. and the Nash Hytor vacuum pump for pulling the vacuum on the larger centrifugal pumps.

The Westinghouse motors are of the drip-proof ventilated type incorporating special features demanded by marine service. The electrical part is the same as in the established S. K. type. The special features introduced for marine service are the protective casing and the ventilation. Both ends of the motor are completely encased, with hinged covers seating on gaskets to give access to the commutator and brushes, and on the under side of the casing are perforated covers which permit ventilation, but exclude foreign objects. Ventilation is effected by a fan on the armature shaft and air ducts through the armature. It is effective enough to permit the same temperature rating to be guaranteed on the enclosed marine type motor as on the open motor. The leads are brougnt out through a heavy brass bushing, leading downwards and affording no access for moisture to the windings.

In addition to the pumps listed in the table there are two 3-stage Worthington air compressors for the supply of starting air and driven by 65 hp. motors at 325 r.p.m.

Included in the auxiliary equipment are, of course, the two fuel oil centrifuges and the two lubricating oil separators, all of the De Laval type. The two oil purifiers are in the thrust recesses, one for each main engine. The two fuel oil purifiers are in the forward end of the engine room and are of the vapor-tight type in order to be able to handle heated fuel. They discharge into a small tank between them, which is fitted with a float feed controlling the switch of the transfer pump that lifts the fuel to the service tank.

On account of the retention of the steam winches on deck the boiler installation is larger than is generally found nowadays on motorvessels. The boiler is of the 3-furnace Scotch type with 2400 sq. ft. of heating surface and arranged for oil burning. The wing furnaces are arranged to be heated by the exhaust gas from the main engines when the vessel is at sea, but in port the oil burners can be put quickly into



*Corner of pump space. In foreground, the vacuum unit for assisting the other pumps*

**Electrically Operated Auxiliary Pumps of the m.s. East Indian**

| Service of Pump | Number | Capacity | Head | Type | Motor Power |
|---|---|---|---|---|---|
| Circulating pumps—distilled water for engine | 2 | 300 g.p.m. | 40 lb. per sq. in. | centrifugal | 15 hp. |
| Circulating pumps—salt water for coolers | 2 | 300 g.p.m. | 40 lb. per sq. in. | centrifugal | 15 hp. |
| Bilge pumps | 2 | 125 g.p.m. | 25 lb. per sq. in. | reciprocating | 5 hp. |
| Fire, bilge and ballast pump | 1 | 300 g.p.m. | 100 lb. per sq. in. | centrifugal | 32 hp. |
| Sanitary and auxiliary circulating pump | 1 | 200 g.p.m. | 50 lb. per sq. in. | centrifugal | 15 hp. |
| General fresh water service and fire pump | 1 | 300 g.p.m. | 100 lb. per sq. in. | centrifugal | 32 hp. |
| Fresh water sanitary pump | 1 | 50 g.p.m. | 40 lb. per sq. in. | rotary | 5 hp. |
| Drinking water pump | 1 | 5 g.p.m. | 20 lb. per sq. in. | rotary | 1 hp. |
| Lubricating oil pumps | 2 | 200 g.p.m. | 40 lb. per sq. in. | rotary | 15 hp. |
| Lubricating oil sump pump | 1 | 10 g.p.m. | 40 lb. per sq. in. | rotary | ½ hp. |
| Circulating pump—salt water for oil coolers | 1 | 300 g.p.m. | 40 lb. per sq. in. | centrifugal | 15 hp. |
| Fuel oil transfer pumps | 2 | 200 g.p.m. | 40 lb. per sq. in. | reciprocating | 10 hp. |
| Fuel oil pumps—for boosting fuel pressure on engines before starting | 2 | ... g.p.m. | 6000 lb. per sq. in. | reciprocating | 4 hp. |
| Fuel centrifuge supply pump | 1 | 100 g.p.m. | 15 lb. per sq. in. | centrifugal | 5 hp. |
| Vacuum pump | 1 | 1 cu. ft. air p.m. | 18 in. vacuum. | centrifugal | 3 hp. |

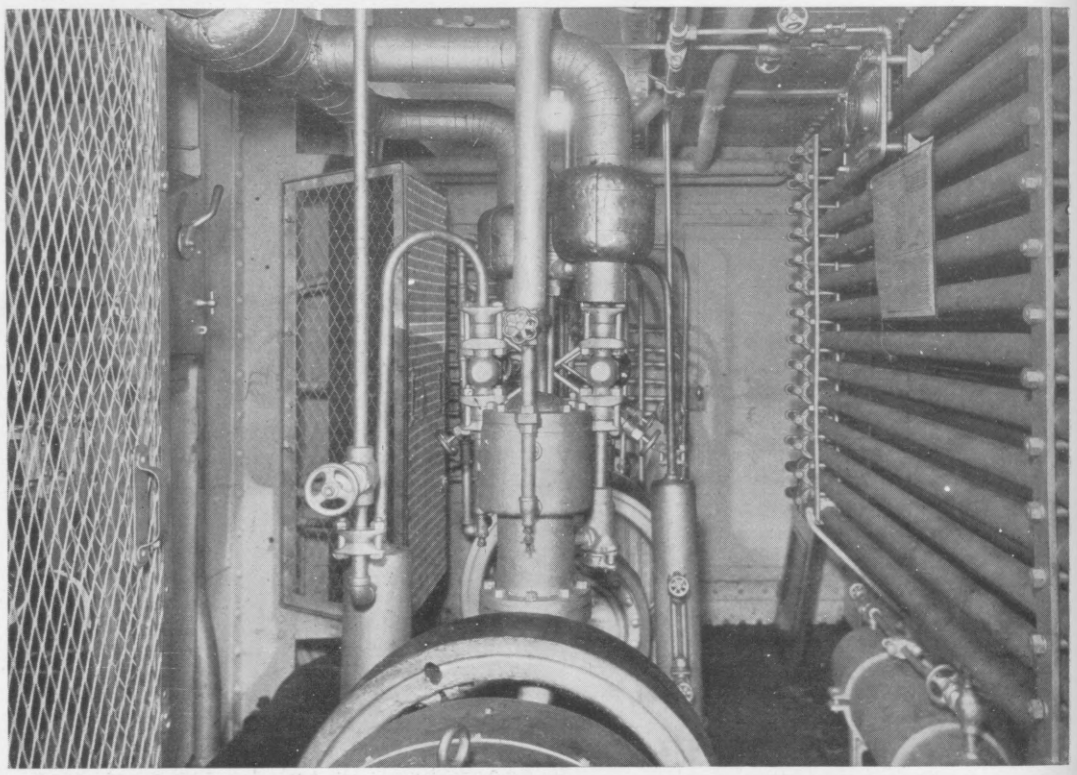
operation in these furnaces as well as in the center furnace. Forced draft is used only when fuel oil is burned.

In connection with the steam system there are a feed water heater and auxiliary condenser, combined air and circulating pump, boiler feed pump and two fuel oil service pumps. Normally steam is used for heating throughout the ship in the living quarters, but not for any power purposes except on deck. Only in port is any large quantity of steam used, the demand then arising from the steam winches, which have been retained evidently because it was considered they would not be in use often enough and for long enough periods to mean a very large waste of money during the course of the year. If at any time the EAST INDIAN should be placed in a service where the winch operation would become an important factor there is no doubt that the electrical type would be installed in order to provide the economy practised in all Ford operations.

A small workshop is provided on the starboard flat and there is a store room on the port side. So far as the main engines and auxiliary engines are concerned spares are carried as called for by the American Bureau of Shipping. For the electrical equipment the Ford engineers have made an innovation by carrying spare armatures for each different generator or motor. The electrical end has hitherto generally been treated like an orphan, just being housed and kept alive, but without anybody taking a real interest in it. The Ford engineers have given it the same attention as they have devoted to every other detail of the ship and machinery.

Outside the engine room the only electrically driven machinery is the steering engine and the ice machines. The former is described in the article relating to navigating equipment. The latter are a pair of 2-ton Brunswick-Kroeschell sets in a separate room next to the galley and providing refrigeration for the fresh meat chamber and for the fruit and vegetable storage.

In the storeroom are two bins for oily wiping cloths, which instead of being thrown away, are kept for laundering in port and subsequent reissue. These cloths, used in place of waste, measure about 16 in. square and are made of cotton in an absorbent texture, grayish blue in color. They are standard in all Ford plants. On account of her service the EAST INDIAN will be in frequent contact with Ford branches or assembly plants where she can exchange the used cloths for clean ones. Their life varies with the caustic strength of the solution in which they are washed, which in turn varies with the work on which they are used.



*East Indian has a couple of 2-ton ice machines for the refrigerated stores*

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ALTHOUGH the new motorliners of 20,000 gross tons each on which Shaw Savill & Albion of London are taking bids will have a speed of 17 knots, these owners never went beyond 11,500 tons gross and 13 knots on their steamers. The extra speed of the motorvessels will save seven or eight days on the passage.

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Two new 14-knot vessels ordered by the Commonwealth and Dominion Line of London for its Australian trade are to be about 465 ft. long with 60 ft. beam and of about 11,600 tons d.w.c., similar in design to the PORT HOBART delivered last year to the same owners. Swan, Hunter & Wigham Richardson will build the ships, one of which will have Doxford engines and the other Wallsend-Sulzer engines.

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Furness Withy have again placed an order for motorships. This time the order went to a British yard, the Blythswood Shipbuilding Co. having secured the contract. The four vessels will be slightly larger than the m.s. PACIFIC TRADER of the same company. They will measure 440 ft. length and 60 ft. breadth and carry about 10,000 tons deadweight. Kincaid's of Greenock, will supply two 8-cylinder H. & W.-B. & W. engines to drive the boats at 13 knots.

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Five ships similar to the PINZON and PIZARRO have been ordered by McAndrews & Co. of London, for their service between the United Kingdom and Spain. The order has gone to Harland & Wolff. These vessels will be of the single-screw type with an engine of about 1750 i.hp. giving a speed of about 12 knots with a deadweight capacity of about 2500 tons.

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Stinnes ships, a fleet of 24 vessels of about 142,000 gross tons, have been purchased by the Kosmos and Deutsch-Australische Lines, which together own 28 steamers and 4 motorvessels of 174,500 tons gross. The two best Stinnes ships are the motorvessels of 5800 tons gross each, under construction at the Weser yard and at the Bremer Vulkan, both to have a Vulcan hydro-mechanical gear drive similar to that of the DUISBURG, already in service.

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Two single-screw freight vessels of 11,000 tons to be propelled by 2-cycle double-acting Diesel engines have just been ordered by the Hansa D. S. Ges. of Bremen.

# East Indian's Navigating Equipment

## Every Modern Aid to Facilitate Navigation Has Been Installed and New Features Introduced

NO ship of the size of the EAST INDIAN has ever had such a complete bridge equipment, it being at least as good as any to be found on the finest passenger liners and better than that of most of the foreign passenger ships. What seems like lavishness however to the older school of ship operators is viewed by the Ford Motor Company as efficiency. Ford engineers cannot understand that such a valuable property as a ship should not be provided with every modern aid to safe and speedy navigation. Ford opinion classifies the gyro-pilot as a precision machine capable of more regularly dependable steering than human agency can provide. In the Ford scheme of ideas the man on the bridge should be accurately posted with information about the execution of orders to the engine room: hence the engine room indicators and comparator. The radio direction finder appeals to the Ford type of mind as a device to assist in the earlier termination of a voyage when thick weather in encountered. The installation of a telephone for communication between the principal rooms in the ship is regarded as another aid to efficiency. Down through the list every item in the equipment has been selected for its value in securing more efficient movement of the vessel as a unit of transportation.

To give a comprehensive view of the items that come under the direct charge of the officer on the bridge the full equipment is set out in the list below:—

### Bridge Equipment on m.s. East Indian

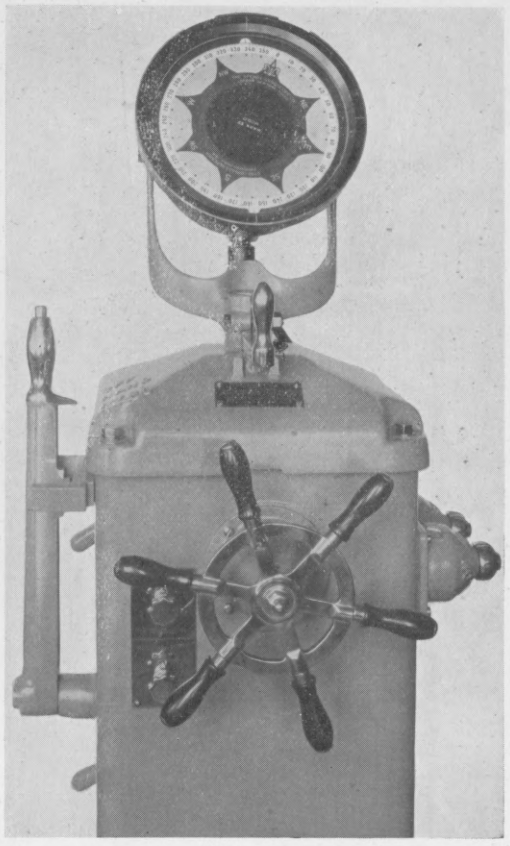
Gyro-compass with repeaters.
Magnetic compass.
Gyro-pilot with automatic, normal wheel and auxiliary control of steering.
Helm angle indicators in wheelhouse and in wing of bridge.
Course recorder.
Radio direction finder.
Submarine signal apparatus.
Navigation light switches and tell-tales.
Pelorus.
Telegraph to hand steering station on poop.
Searchlight on foremast, controlled from bridge.
Air whistle and steam whistle, with automatic control and general alarm.
Radio transmitter and receiver.
Recording telegraph to engine room.
Engine revolution indicators and comparator, with tell-tale in wing of bridge.
Loud speaking telephone to engine room.
Voice tube to engine room.
Ship's automatic telephone system.
Rich fire indicator.
Lux fire extinguishing system with central control.

Items such as chronometer, sextant, barometer, charts, binoculars, flags, etc. have not been included, because no ship goes to sea without them.

### 2-Unit Gyro-Pilot

For the gyro-compass a special room has been provided on the shelter deck adjacent to the first officer's and second officer's cabins. This room is glass panelled on the alleyway sides and is well ventilated in order that the heat from the moving parts shall be continuously carried away. In the same room are the motor generator and control switchboard. The gyro-compass operates four repeaters, one above the gyro-pilot unit in the wheelhouse, one in the radio direction finder, a bearing repeater on top of the wheelhouse, and one on the desk in the captain's office.

A new style gyro-pilot has been introduced by the Sperry Gyroscope Co. and installed for the first time on the EAST INDIAN. It is termed the 2-unit type and is a further development of the model in-



*New 2-unit gyro-pilot*

stalled on the motor tanker J. W. VAN DYKE. Basically the Sperry system of gyro-control has not been altered since 1922. The departure in the new type is of a mechanical nature, the electric motor having been transferred from the bridge unit to a power unit introduced aft, which explains the use of the term "2-unit" gyro-pilot. The single-unit type of gyro-pilot was developed for use with telemotor control. The 2-unit type provides direct transmission of the gyro control movements to the steering engine without the medium of a telemotor or other device.

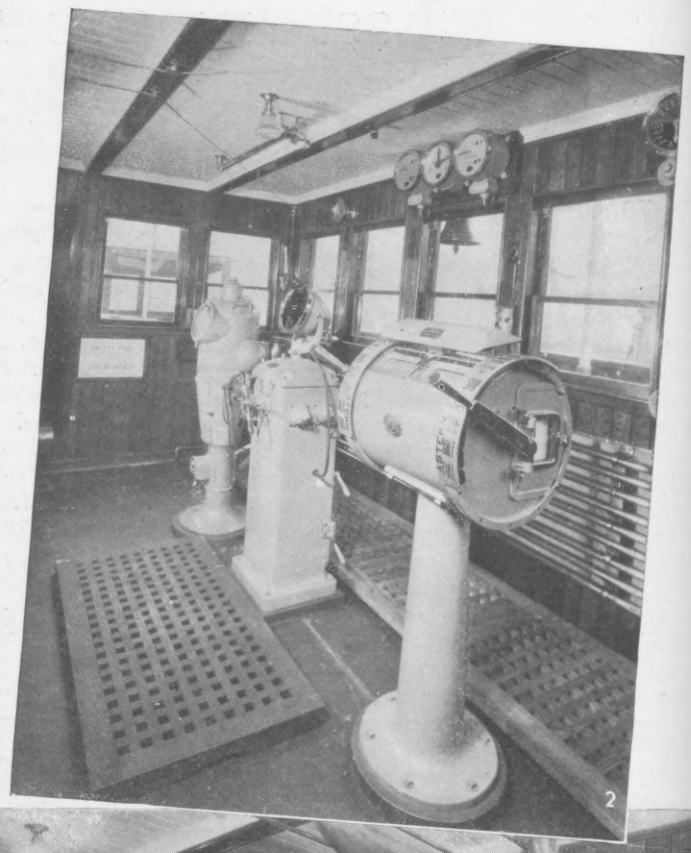
On the side of the gyro-pilot is a selector lever with three switch points, one for the automatic gyro control of the steering, one for normal wheel steering and one for the auxiliary control. For the normal wheel steering the gyro course-changing wheel is utilized as a handwheel, controlling the steering engine through the same electrical mechanism normally used for the gyro control. For the auxiliary control a handle has to be fitted over a square key in the top of the gyro-pilot, in the same manner as the motorman on an electric car fits his controller handle. This handle does nothing more than close a port switch or starboard switch actuating remote control switches in the steering engine house, and when it is used the helm is brought back to mid-position by swinging the handle over to the opposite contact. In reality, therefore, the 2-unit gyro-pilot provides, first, a standard automatic gyro-pilot, secondly, alternative means for normal wheel steering by hand and, thirdly, a pair of ordinary remote control switches entirely independent of the gyro-pilot mechanism. Operation of these three alternatives becomes a little plainer when their relation to the steering engine is studied.

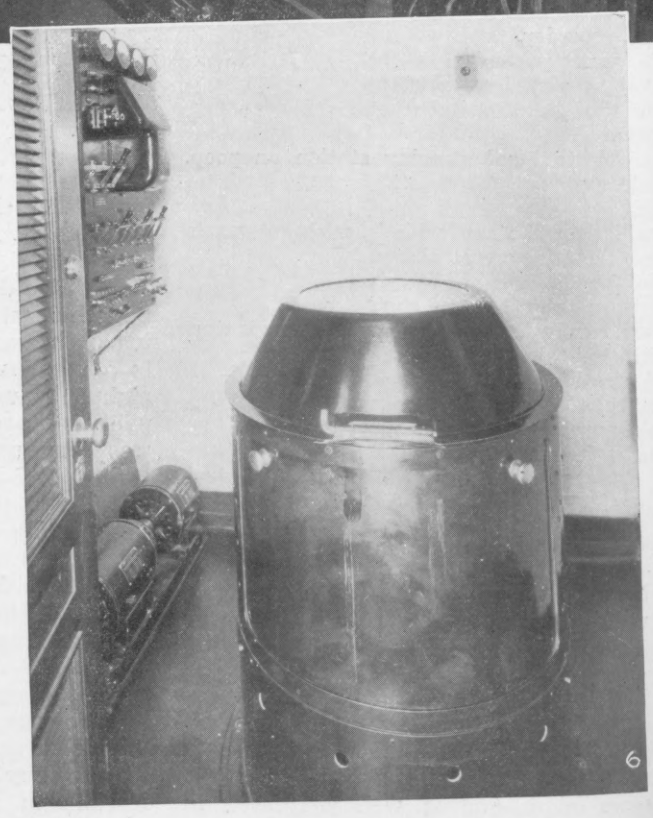
The steering engine itself is an electric-hydraulic unit built by the American Engineering Co., consisting of two opposed hydraulic cylinders, the rams of which form a single unit linked to the helm, with a continuously running hydraulic pump unit to transfer oil from one cylinder to the other, thus producing the helm movement through the displacement of the ram unit. Control of the hydraulic system is obtained by a rod altering the stroke of the pump plungers, and a follow-up mechanism restores the pump plungers to normal when the helm has been moved over to the desired angle.

Movement of this control rod is possible by any one of a number of different methods. In modern practice the old style telemotor is being abandoned in favor of electrical methods not so susceptible to lost motion and to changing operating conditions. The electric-hydraulic steering engine is a very positive piece of mechanism, which for all practical purposes can be regarded as entirely free from lost motion, holding the rudder very firmly and suppressing slapping or jarring. The use in conjunction with it of any type of control transmission that does not work positively and uniformly seems a little incongruous.

On the EAST INDIAN the Sperry control transmission assures positive operation under all conditions. Its power mechanism right alongside the steering engine consists essentially of two magnetic contactors closing an electric motor circuit, one contactor being for one direction of rotation and the other contactor for the opposite direction, the motor being worm-geared to a rod operating the control rod of the electric-hydraulic steering engine and geared also to a follow-up transmitter, controlling the follow-up motor of the gyro-pilot unit on the bridge. This gyro follow-up mechanism is not to be confused with the follow-up mechanism of the steering engine, but is part of the Sperry control.

There are thus three principal units in the steering arrangement, the first being the Sperry control unit on the bridge, the second being the Sperry power unit, which in turn controls, third, the electric hydraulic steering engine.





1. *Frank Hudgins, master of the East Indian, at the emergency steering telegraph.* 2. *Wheelhouse.* 3. *Wheelhouse bulkhead.* 4. *Chart-room.* 5. *Radio cabin.* 6. *Gyro-compass room*

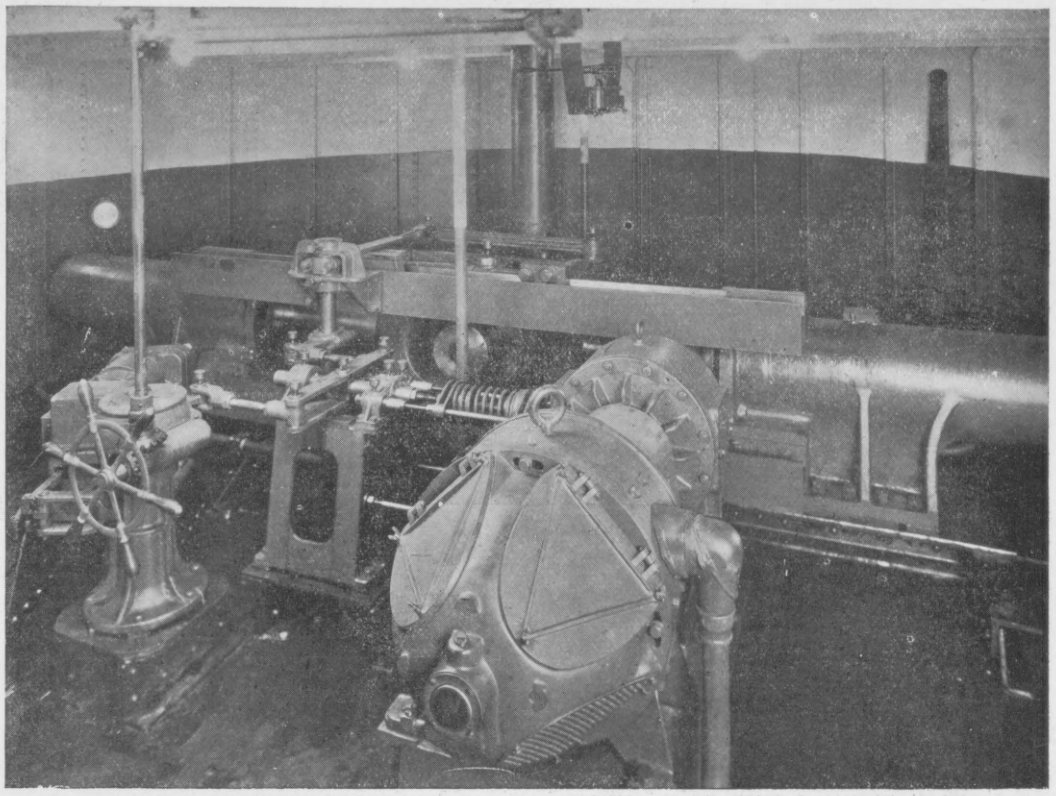
When the gyro-pilot is steering automatically, any movement of the ship's head exceeding the angle determined by the officer on the bridge as suitable for the prevailing sea and weather causes an electrical contact to be made automatically in the control unit, which thus closes one of the magnetic contactors or remote control switches of the power unit acting on the control rod of the hydraulic pumps of the steering engine. The closing of the magnetic contactor in the power unit determines the direction of rotation of the electric motor, which then simultaneously operates its worm geared steering rod and the transmitter that sets in motion the follow-up motor in the gyro-pilot unit on the bridge. When the motor of the power unit has moved the transmitter to the point where the follow-up mechanism in the gyro-pilot control breaks its contact the power motor stops, and the position of the controlling rod at that moment fixes the angle to which the helm will be put over by the transfer of oil from one hydraulic cylinder to the other of the steering engine. The ship's head in the interim swings over, and contact again is made in the gyro-control unit on the bridge, but this time causing the other magnetic contactor of the Sperry power unit to close and therefore reversing the direction of rotation of the power unit motor, causing the helm to return until the ship is headed again on her course.

For the normal wheel steering the principle of operation is almost the same, the only distinction being that the gyro-compass does not automatically control the steering. The helmsman instead turns the wheel on the front of the gyro-pilot and, this wheel being directly connected with the contact ring inside the control unit, regulates the Sperry power unit in exactly the same manner as the gyro-compass does. This wheel is the one used for setting the ship's course when the automatic gyro-pilot steering is used. It is a larger wheel than is used for setting the course on the single-unit gyro-pilot in order that it may be more conveniently turned by hand. The angle of helm is proportional to wheel movement.

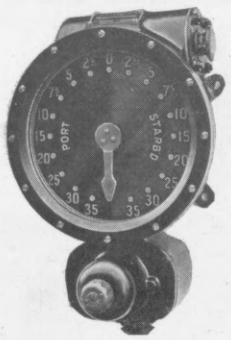
With the auxiliary steering the operating conditions are sensibly different. When the auxiliary control lever is used, the follow-up motor in the Sperry control unit and the follow-up transmitter in the Sperry power unit are both idle. Moving the auxiliary control lever to one side closes the circuit to one of the magnetic contactors in the Sperry power unit, causing the motor to rotate in a corresponding direction and move the worm geared steering rod. This operation will continue until the auxiliary control lever is moved back to the mid-position. When it is moved to the other side it will reverse the operation. The helm angle is in no way proportionate to the position of the auxiliary control lever, because the latter performs no other function than to hold one or other of the magnetic contactors closed for the length of time determined by the helmsman. When the auxiliary control lever is being used the helmsman must, therefore, watch the helm angle indicator in order to know how far he moves the helm over. It provides a third system of power steering at very little extra cost.

The automatic steering is for use in open waters and the normal wheel steering for use in channels or harbors. The auxiliary system is a stand-by, with independent wiring connections between the bridge and the steering engine house, and requires only that the motor of the Sperry power unit and the magnetic contactors shall be in operating condition. In the event of total failure of electric power, either through damage to the generator, switchboard or cables in the engine room or through breakage of the cables between the bridge and the steering engine house, resort can be made to hand steering aft. If power is still available for the hydraulic electric steering engine the control of that unit can be performed by hand in accordance with orders received by the mechanical telegraph from the bridge. If that should fail, then the ship can be steered by direct hand operation of the helm, in accordance with orders received by mechanical telegraph.

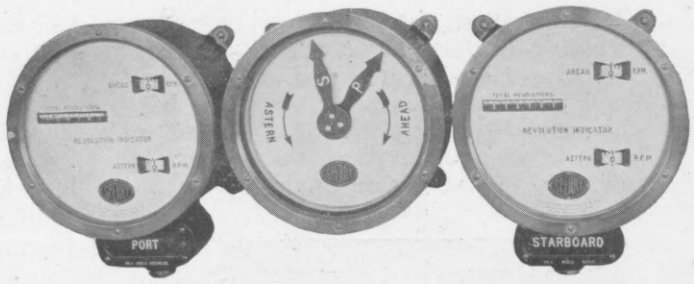
The helm angle indicator installed on the EAST INDIAN is made to Navy specifications by the Sperry Gyroscope Co. The operating attachment is a simple contact device consisting of a light arm attached to the rudder stock and making contact on a frame fixed to the deck nearby. It transmits electrically to an indicating dial in the wheelhouse and to a similar dial in the starboard wing of the bridge. Half of the indicator dial is green and the other half red. It is calibrated in divisions of 2½ deg. up to 10 deg. and then by steps of 5



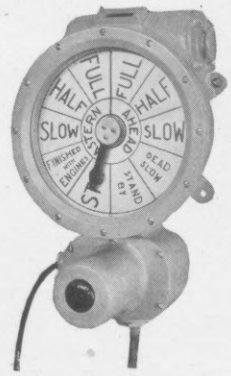
*Views of the steering engine and control. In the foreground at top, the oil pump unit. In the foreground at bottom, the Sperry control power unit*




*Helm angle indicator*




*Engine speed indicator and engine comparator*




*Telegraph tell-tale and blinker*

deg. up to a maximum of 35 deg., for port and starboard respectively. The dials can be illuminated by a light inside the case of the instrument, three intensities of lighting being provided, bright, medium and dim.

### Engine Room Telegraph

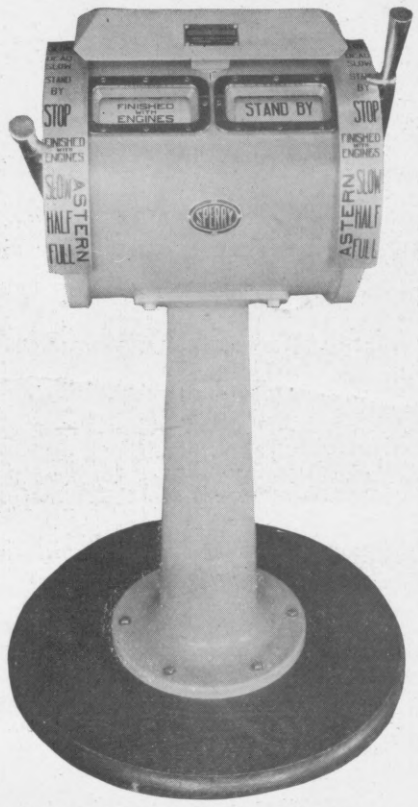
At the instigation of the Ford engineers an improved type of engine room telegraph was devised for the EAST INDIAN. It is an electrical device. In the bridge instrument the separate telegraphs for the port and starboard engines are combined on one pedestal. The two levers are on the ends of the casing, and the orders are in legible block letters on metal bands immediately adjacent to the levers, this being in contrast with the hitherto universally used method of printing the orders on dials at the side of the telegraph. One stands squarely in front of the instrument and sees clearly the orders one rings down to the engine room. When the orders are repeated back to the bridge they show plainly and separately through port and starboard windows in the casing. At night the bridge telegraph is illuminated by lamps under a shield across the top of the instrument. The actual orders that can be transmitted are:—

Ahead: Full—Half—Slow—Dead slow.
Stop—Stand by—Finished with engines.
Astern: Full—Half—Slow.

When either of the levers is moved, a bell begins to ring and a red light shows, both continuing until the correct reply from the engine room shows in the window in the middle of the casing. If the order has been misunderstood in the engine room and the reply rung back to the bridge does not correspond with the bridge order, the bell continues to ring and the red light will still show.

In the wings of the bridge, tell-tale dials are installed, on which the orders are marked in sectors, as on ordinary telegraph dials. When either lever of the bridge telegraph is moved, the needle on the corresponding port or starboard tell-tale dial moves to the corresponding order and a red light glows above the dial, until the order is repeated back from the engine room. A description of the telegraph dials in the engine room is given on page 198 in the article about the main engines of the EAST INDIAN.

Another feature of the Sperry telegraph system is the paper record made of all orders transmitted from the bridge. For each engine there is a separate record. On the recording paper horizontal lines indicate the time of day. Any movement of the telegraph lever makes a zig-zag mark across the paper at the exact time at which the order is sent down to the engine room, and as soon as the order is repeated back a straight line is continued across the record to a point which chronicles what the order was. Reading the orders on the record is made easy by vertical lines dividing the




*Bridge telegraph—recording type*

strip of paper into as many sections as there are different orders on the telegraph, namely ten. Reference to the specimen telegraph record reproduced on page 207 shows how clear the characteristic marks are. In the same illustration can also be noticed on one side a separate record of the engine stops or reverses, obtained by means


*Engine room dial of telegraph*

of special contact makers on the revolution transmitter attached to the engine, an instrument to which further reference is made below.

Normally the officer on the bridge pays no attention to the recording part of the telegraph. The records are made automatically and are for use only in investigations, disputes, law suits, etc., having a similar value to the records of the ship's course made by the Sperry course recorder.

### Revolution Indicators and Engine Comparator

Another new instrument installed on the EAST INDIAN is the engine comparator which indicates the direction of rotation of the engines and their relative speed. It is a simple device operated by the aid of two revolution indicators and is a Sperry production. The revolution indicators are electrically connected with the Sperry revolution transmitter on the port and starboard engines respectively, and each comprises a counter to record the total revolutions of the respective engines, taking no account however of astern revolutions. The r.p.m. ahead or astern, as the case may be, is shown through two separate windows in the dial, one window or other consequently always showing a zero, because the engine cannot turn ahead and astern at one time.

Between the two revolution indicators for the port and starboard engines is mounted the engine comparator, which has two pointers connected by chains to the respective indicators. One pointer is painted red to correspond with the port engine, and the other is green to correspond with the starboard engine. Their direction of rotation corresponds with that of the engines. When the red pointer turns anti-clockwise it indicates that the port engine is going astern. When the green pointer turns clockwise it shows that the starboard engine is going ahead. When both engines are turning in the same direction at the same speed the two pointers will maintain the same relative position in turning. When their relative position changes while they are rotating, it is an indication that the engines are turning at different speeds.

The actual rate of rotation of the pointers is not calibrated and is not needed because the engine speed is shown exactly on the revolution indicators. Connected with this group of instruments is a tell-tale light in the starboard wing of the bridge, installed just underneath the telegraph tell-tale dial. It consists of a red light which blinks for every revolution. The blinking light is not, of course, a direct-reading speed indicator, but the officers will soon become acquainted with the rate of blinking

that corresponds with the normal engine speed and will soon be able to judge engine speed by means of it. That is not really its purpose however. It is intended to serve as an indicator when the engines are in motion during the periods of maneuvering, and that is why it is installed under the telegraph tell-tale dial. When the ship is at sea and on a clear course the tell-tale lights can be switched off.

### Radio Equipment

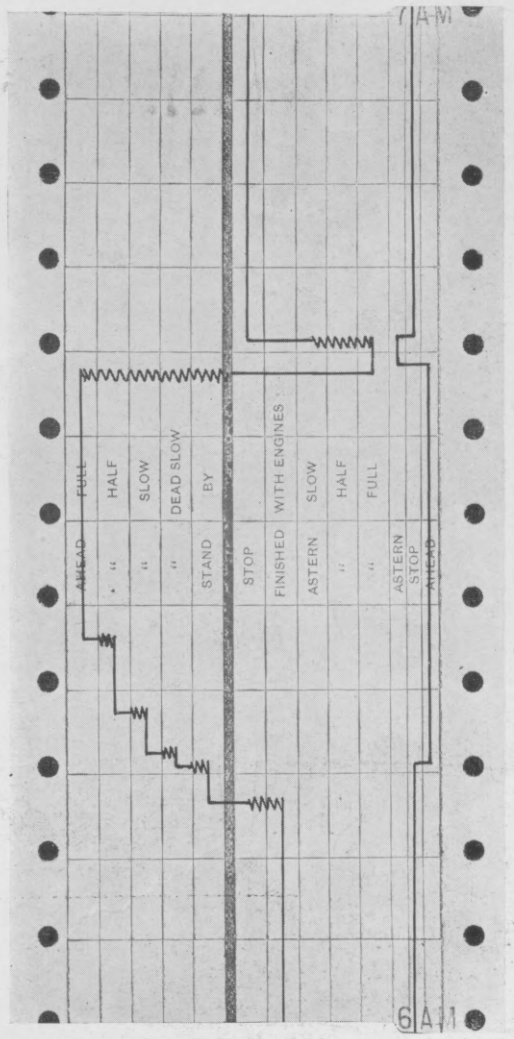
In the chart room an R.C.A. radio direction finder has been installed, with a Sperry gyro-repeater in place of a magnetic compass. This instrument comprises a standard R.C.A. super-heterodyne receiver suited to wave lengths between 450 meters and 1600 meters, in conjunction with a directional frame. The bearing of the radio signals is found by moving the frame until the minimum signal strength is noted. A ground glass plate with an etched minimum line is attached to an extension of the frame shaft just above the gyro-repeater so that the bearing can be read directly. For transmission of commercial messages an R.C.A. tube transmitter is installed in the radio room, and the Navy standard type of receiver is used.

### Other Bridge Equipment

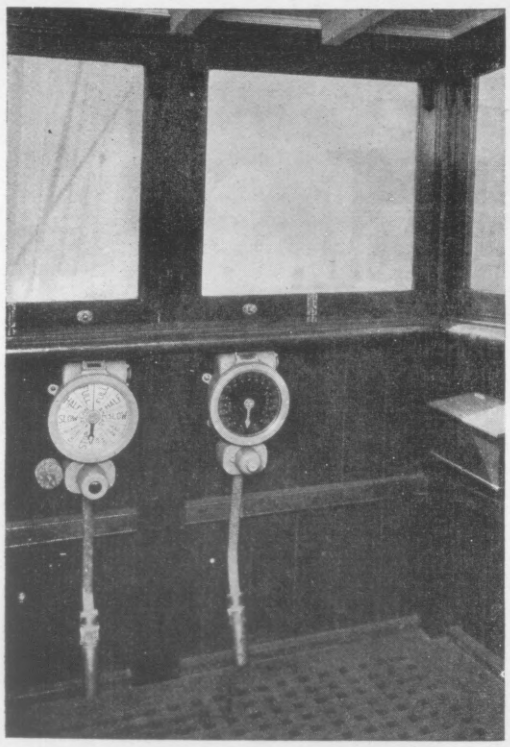
Of the other equipment mentioned in the list given at the beginning of this article, the only further explanation needed is of the searchlight, ship's telephone system and fire equipment.

The searchlight is of the incandescent lamp type and can therefore be mounted on the foremast because, unlike an arc type of lamp, it does not require constant attention when in use. It is electrically controlled by a lever in the wheelhouse, the fore and aft movement of which depresses or elevates the beam, while the transverse motion of the lever swings the beam through the azimuth. It is of the Sperry type.

The ship's telephone system provides communication between the wheelhouse, captain's office, first officer's cabin, engine room, chief engineer's cabin, chief steward's cabin, galley, radio cabin and crew's quarters aft. It is a considerable time saver, enabling communication to be obtained quickly and without the delay inevitable when a seaman has to be called and sent around the ship to find somebody.




*On the Sperry telegraph record one hour covers 6 in. of paper strip, with sub-divisions for each 5 min. In the illustration above, an order was given at 6.13 a. m. to "stand by." The record shows this and subsequent orders to have been properly answered, and indicates that the engines were started almost immediately and in the proper direction following the "ahead dead slow" order at 6.16 a. m. At 6.38 a. m. engines were ordered from "full ahead" to "full astern," and a lapse of about 1 min. will be noted before the engines were reversed.*



*Wing of bridge with tell-tales*

### Fire Equipment

A Rich fire detecting system has been installed in all the holds, 'tween decks and spaces such as paint locker, etc. The control cabinet is mounted in the wheelhouse with an exhaust connection to the outside. For fire extinguishing a complete installation of the Lux system has been made. The batteries of gas containers are housed in the forecastle, and the lines to the various spaces in the ship are separately controlled. A diagram, supplied by Walter Kidde & Co., manufacturers of this system, shows the number of gas bottles that have to be discharged to extinguish fire in any particular part of the vessel. When, therefore, smoke is shown by the Rich detector and investigation shows that a fire is burning, there is no need to discharge more gas than the space requires and the contents of the other batteries will be conserved.

## Foreign Trade by Ports

Water-borne foreign commerce of the United States in the fiscal year 1925 exceeded 93,250,000 tons, more than 78 per cent of which was conducted through 19 American ports handling each in excess of 1,000,000 cargo tons of imports and exports.

New York, the premier port, increased her total to 22,200,000 tons, an increase of 5 per cent over the transactions of that port in the previous year and substantially one-quarter of the volume of the total foreign trade of the country.

The following table contains a list of the ports handling in excess of 1,000,000 tons, together with the tonnage total of each:—

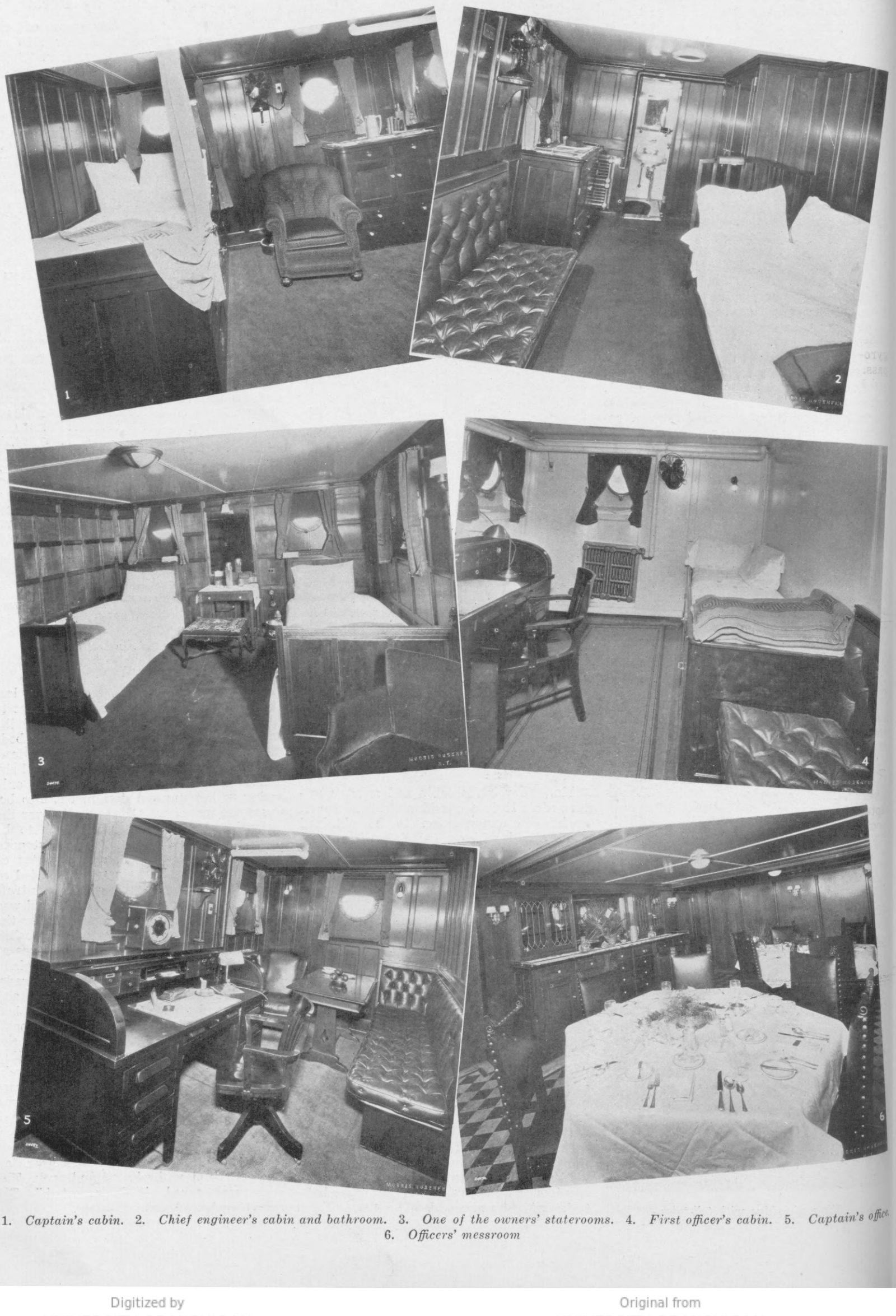
**Tonnage at Various Ports**

| | Tons |
|---|---|
| New York, N. Y. | 22,222,965 |
| New Orleans, La. | 9,410,331 |
| Philadelphia, Pa. | 5,736,805 |
| Baltimore, Md. | 5,485,071 |
| Los Angeles, Cal. | 3,751,700 |
| Buffalo, N. Y. | 3,384,339 |
| Galveston, Texas | 3,143,701 |
| Norfolk, Va. | 2,912,890 |
| San Francisco, Cal. | 2,681,199 |
| Boston, Mass. | 2,302,803 |
| Houston, Texas | 2,198,504 |
| Port Arthur, Tex. | 1,804,128 |
| Newport News, Va. | 1,664,427 |
| Baton Rouge, La. | 1,186,494 |
| Mobile, Ala. | 1,090,489 |
| Perth Amboy, N. J. | 1,041,043 |
| Cleveland, Ohio | 1,041,016 |
| Seattle, Wash. | 1,036,739 |
| Portland, Ore. | 1,009,443 |

The survey prepared by the Bureau of Research of the Shipping Board presents striking evidence of the development of ports in the Southern States. Every State from Virginia to Texas shows an increase over 1924.

## A Foredoomed Ship

"Among the recent reports of ships lost there is one which is of special interest to Sweden. This was the total loss of the motorship PAMIR, built at the Finnboda yard and fitted with Swedish Atlas Diesel Polar motor. When she was completed she attracted considerable attention, not only owing to her unusual design, but also because she was about to take a trip over the Atlantic. The voyage, which was to be made under the Swedish flag, was stopped by the Swedish Government Inspector of Shipping, as the boat was not regarded as being suitable for anything but river traffic. The PAMIR was an oil tanker and was originally built for Nobel Brothers for the Russian river traffic. She was first called the SKIF, but after lying for five years at Stockholm was sold to the New England Oil Co., Boston, for the West Indies trade. After the sale she was overhauled and strengthened at the Götaverken. She had practically no draught—8 ft.—in comparison with her 315 ft. length, and as she was looked upon as unsuitable for trading in waters where the hull would be subjected to severe strain, the voyage across the Atlantic was anticipated with forebodings. Only the fact that good weather was experienced was responsible for her safe arrival on the other side. A couple of weeks ago she ran on a sandbank near San Carlos; the stern broke off and sank. The crew was saved, it is reported."—*The Scandinavian Shipping Gazette.*



1. *Captain's cabin.* 2. *Chief engineer's cabin and bathroom.* 3. *One of the owners' staterooms.* 4. *First officer's cabin.* 5. *Captain's office.* 6. *Officers' messroom*

# Living Quarters on the East Indian

## Endeavor Made to Create a Homelike Appeal in all the Living Quarters Aboard the Ship

FURNISHINGS, trim, fittings, lighting, ventilation and plumbing in all the EAST INDIAN'S quarters excel the same features on any vessel of her size, but this does not mean that they are lavish.

The purpose has been to provide every officer and member of the crew with accommodation that affords a sufficient measure of comfort and attractiveness to make a homelike appeal. With the same object in view the standard of cooking and messing has been raised considerably beyond the average. The Ford conception is that happy workers are good workers.

In accord with the superior character of the living quarters and messing, circumspect attention to cleanliness is demanded from all. Rooms must be kept spick and span, and everybody off duty is required to wash and brush up. Before going to meals a man must wash and put on a clean uniform—uniforms are provided by the owners for everybody on the ship's articles. The rule of cleanliness minimizes the physical depreciation of the property, and a man who could not observe it would not be signed on again.

Both the captain and the chief engineer have an office in addition to a cabin and bathroom. The first officer, the first assistant engineer and the chief steward each have a bathroom connected with their respective cabins. The second and third officers share a bathroom, as do the second and third assistant engineers. All bathrooms have tiled walls and floors and are fitted with showers, washbasins—surmounted by large mirror with lights on both sides—and toilets. Good bathroom capacity is provided for the engine room and deck crew. Throughout the ship all the plumbing is of brass or copper as specified, with exposed parts nickel plated.

Officers, engineers, galley crew and radio operator are housed amidships and the seamen and oilers, aft. The messrooms are amidships, near the galley.

The captain's quarters, immediately below the wheelhouse and chartroom, extend the full width of the bridge house and consist of an office, bedroom and bathroom with tub and shower. These rooms are panelled in butternut with mahogany finish. The furniture is mahogany, leather upholstered in the office and velvet covered in the bedroom. Floors are carpeted over a layer of felt. The bedroom is the larger of the two rooms and serves partly as a living room.

On the boat deck, directly beneath the captain's quarters, are the owners' rooms, consisting of two staterooms, walnut panelled, fitted with twin beds and writing desks and having private bathroom with tub and shower. Each room has a settee and easy chair, and a cedar lined clothes closet is provided.

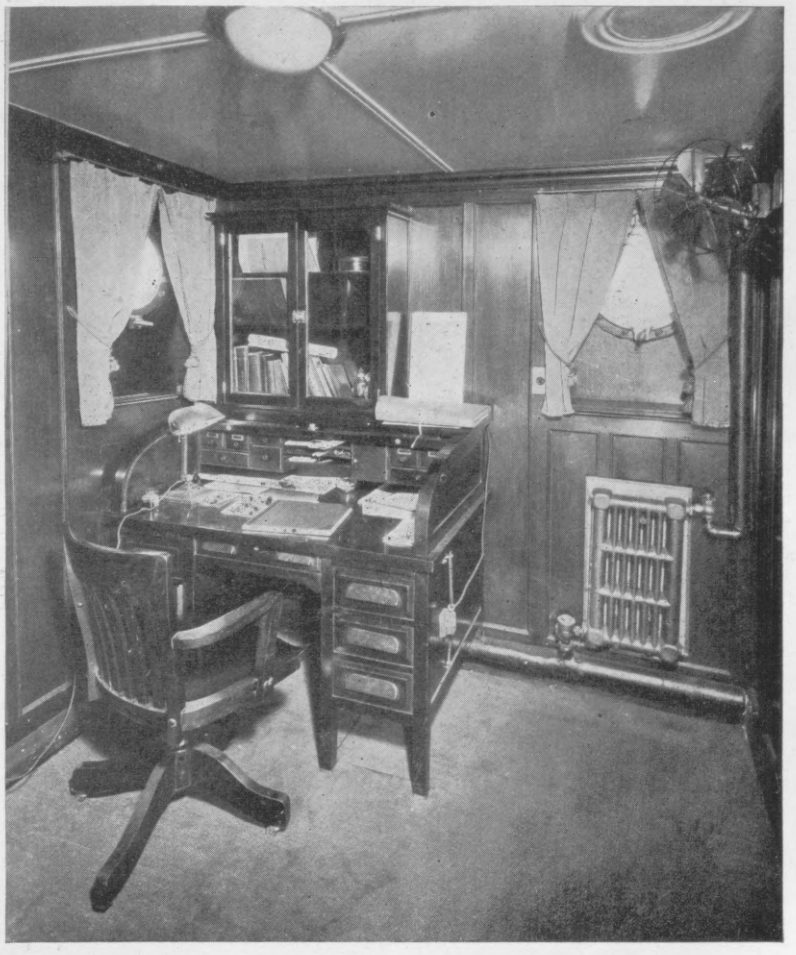
At the after end of the boat deck is the radio house and hospital, the latter containing three berths. The radio operator's cabin is both workroom and sleeping cabin, the radio instruments being on one side and the berth and lockers on the other side.

On the shelter deck the forward end of the house is occupied by the officers' messroom with the first officer's cabin on one side and the chief steward's on the other. This messroom is oak panelled, with leaded tint windows covering the ports, rubber tiled floor, oak tables, sideboard and chairs.

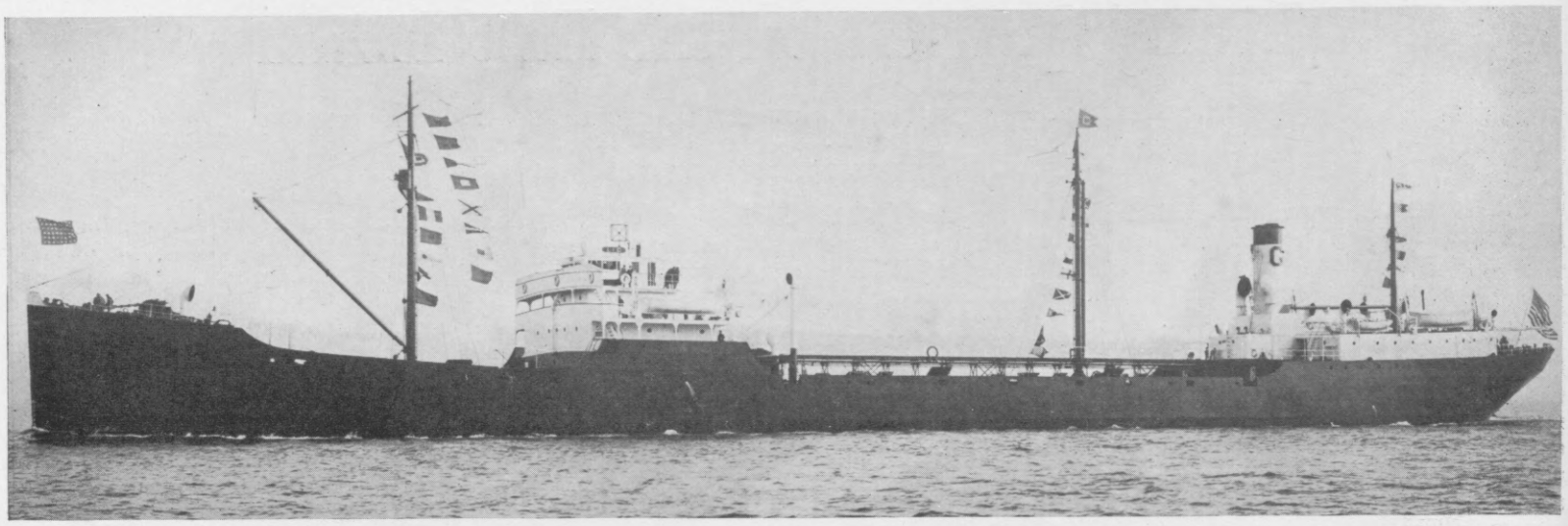
Along the port side are the cabins of the second and third officers, second and third assistant engineers and first assistant engineer, with the chief's suite consisting of office, cabin and bathroom at the after end. The chief's quarters are finished in mahogany and contain mahogany furniture.

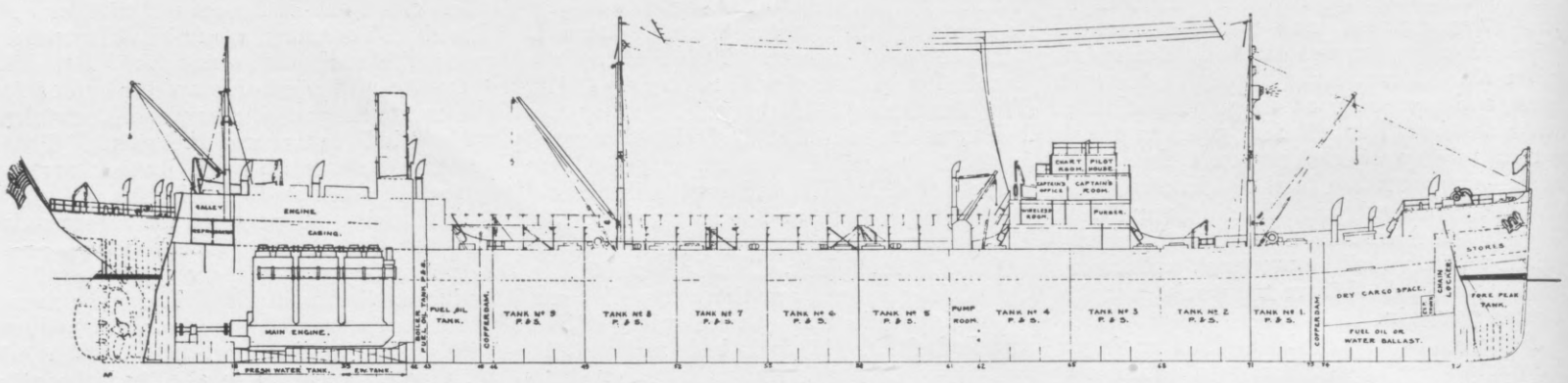
On the starboard side are the cabins for the cooks, messboys, oilers and electrician, with tiled bathrooms between. These rooms are provided with leather covered settees in addition to the berths.

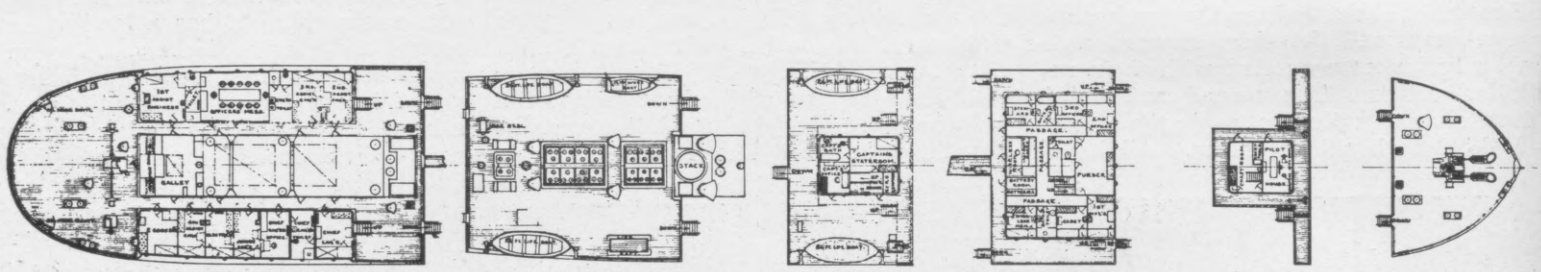
Aft, under the poop, is the accommodation for the oilers and deck hands. The bo'sun and carpenter share quarters, with a bathroom for themselves. The other rooms are of various sizes, for two or three men, with a large bathroom, washroom and toilet. This accommodation is sheathed throughout, and each room has a leather covered settee and clothes lockers. The middle space between these rooms is being converted into a living room for the men, and a large oilskin and boot locker is provided near the entrance.

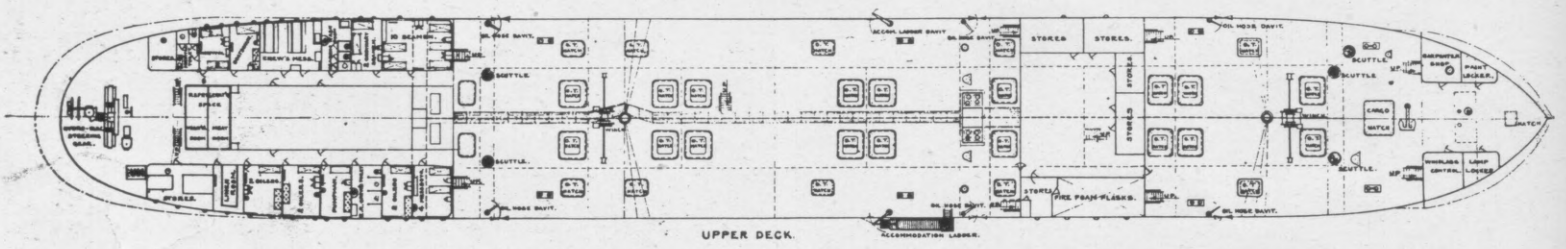


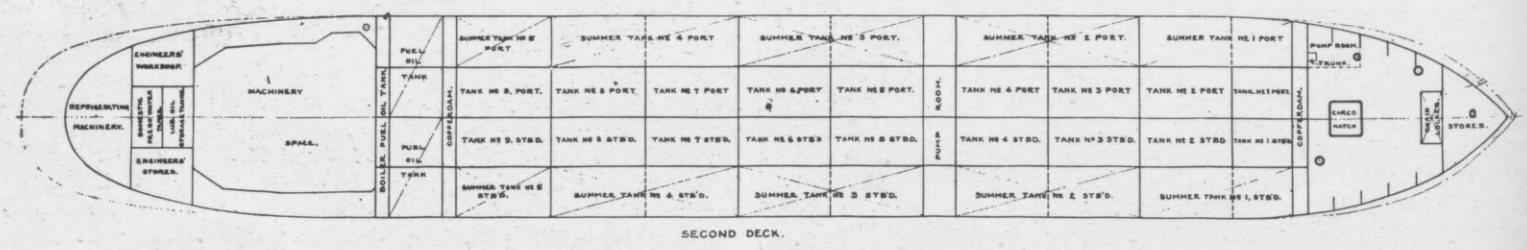
*At left, captain's bathroom with glass enclosed shower over tub. At right, chief engineer's office*

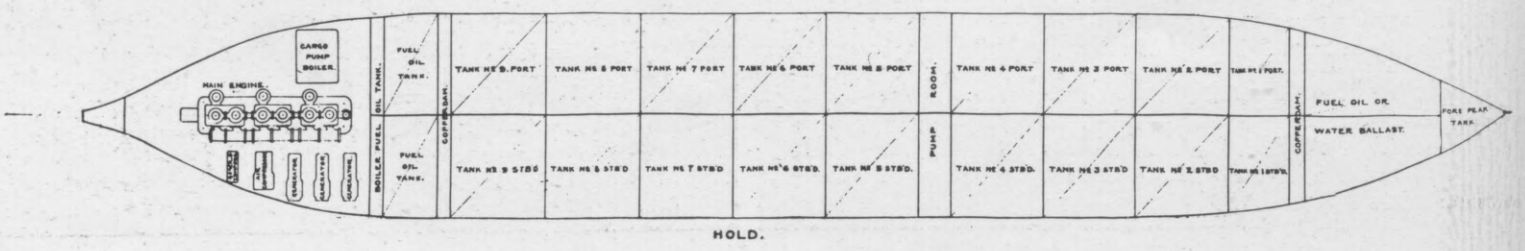





*General Petroleum Corporation's converted tankship Lio, with inboard profile and deck plans showing her internal arrangement after conversion*

# General Petroleum Motortanker Lio

## Single Screw Vessel of 10,250 Tons d.w.c. and 2900 s.hp. Converted from Steam to Motor Power

THE largest Diesel engine constructed on the Pacific Coast has just been installed in the General Petroleum Corporation's tankship LIO built originally by the Baltimore Shipbuilding & Drydock Co. in 1921 for the account of the U. S. Shipping Board and fitted then with three Scotch boilers and geared Parsons turbines of 2800 s.hp. The vessel was purchased by the General Petroleum Corporation of Los Angeles from the Shipping Board under an agreement to convert her, and the contract for making the conversion was awarded to the Bethlehem Shipbuilding Corporation, which undertook the work at the Union plant in San Francisco.

This installation is the largest 2-cycle Diesel engine conversion effected in the West and the next to the largest in the world. Not only is the main engine the product of the Bethlehem Shipbuilding Corporation, but almost all of the auxiliaries were built by the same firm, thus making a unified installation. The main engine was constructed and erected in the shops of the Union plant and installed in the ship without shop trials. After a short dock trial and Bay trials the vessel proceeded on her maiden voyage.

By referring to the installation drawing, it can be seen that one boiler was retained for operating the cargo pumps and winches. Due to the fact that the ship is scheduled to carry refined oil and gasoline from San Pedro to Great Britain, the steam cargo pump installation was considered economical and practical. The ship will only discharge about five cargoes per year, so that it was not considered advisable to go to the expense of converting the cargo pumps to electric drive, which would have entailed the installation of motors in separate gas-tight compartments properly ventilated to prevent the possibility of explosion. Moreover, in London the port authorities do not permit a vessel to provide power for discharging its own cargo. For this reason no boilers or motors can be used for discharging, steam being furnished by the port authorities to operate the cargo pumps.

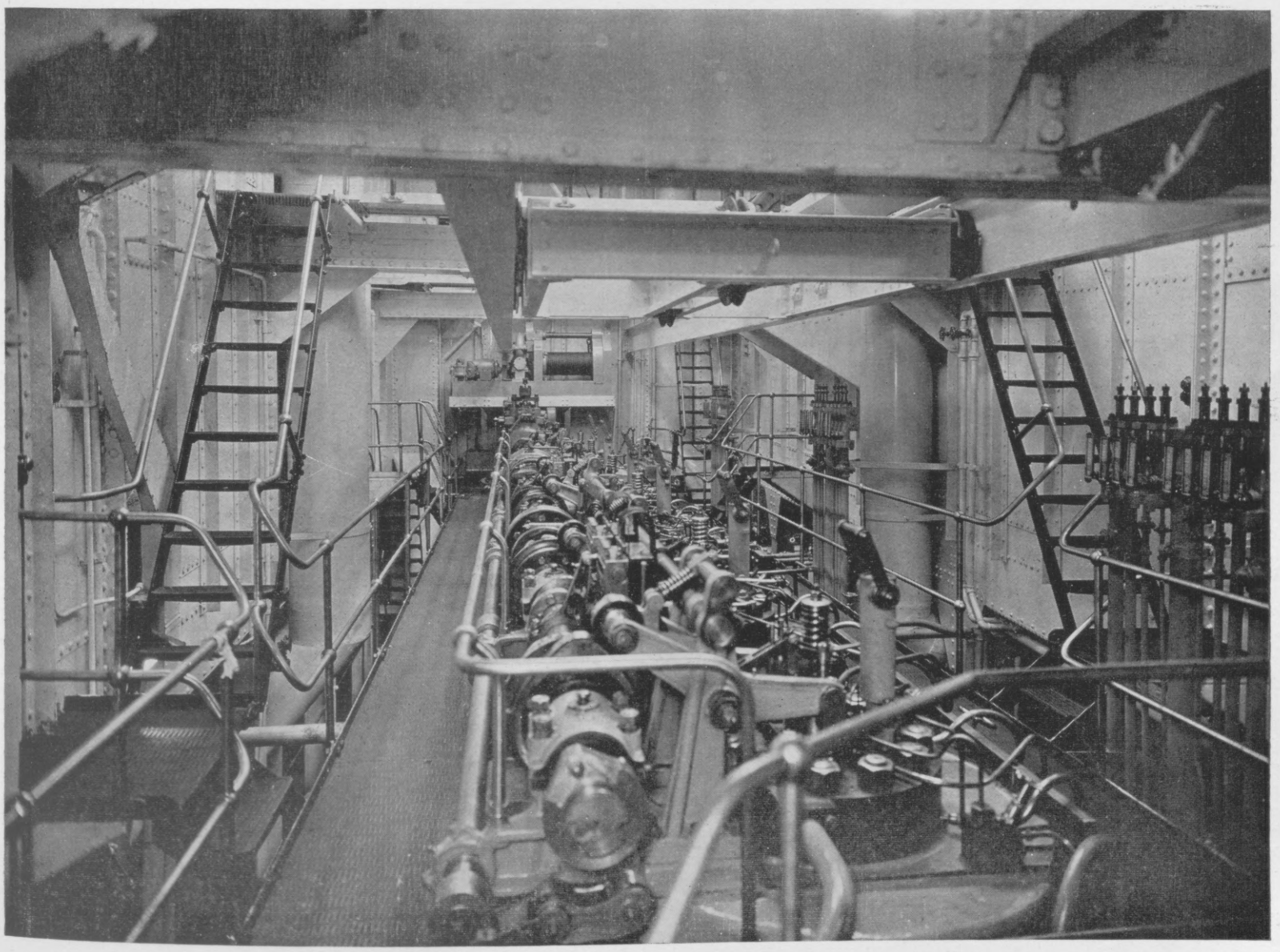
When operating as a steamer with geared turbines, the LIO would require 16,000 bbl. of fuel to make the round trip from San Pedro to London. As a motorship she will require only 6,200 bbl. to make the same voyage. About 10,000 bbl. of fuel are thus saved on one trip, permitting that extra volume of gasoline to be carried as cargo and delivered at London. The gross revenue of the trip is therefore materially increased by the installation of the Diesel engine.

### Principal Characteristics of the Hull

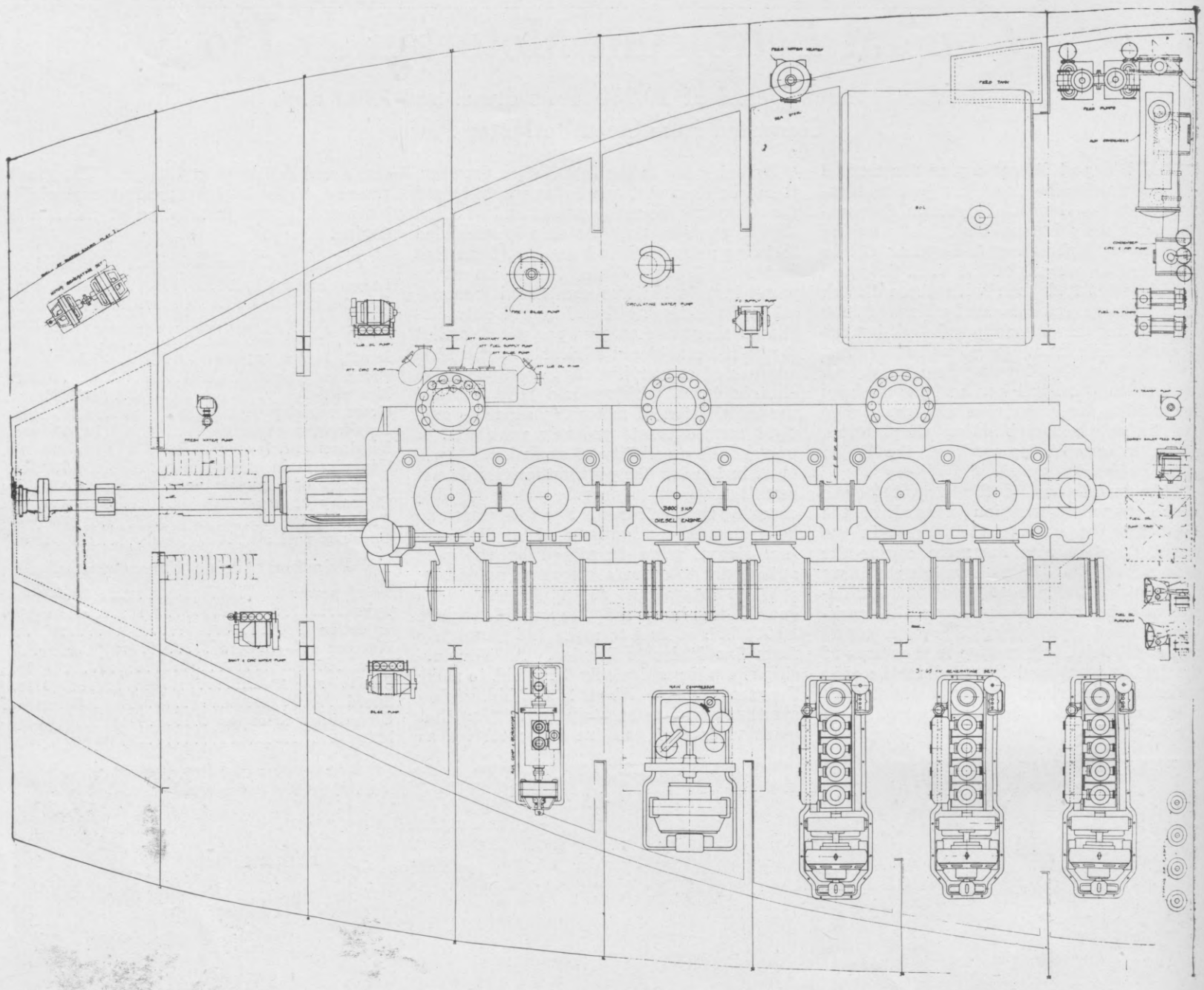
| | |
|---|---|
| Length overall | 250 ft. 0 in. |
| Length b.p. | 430 ft. 0 in. |
| Beam, molded | 59 ft. 0 in. |
| Depth, molded | 33 ft. 3 in. |
| Draft, loaded, summer | 25 ft. 4½ in. |
| Block coefficient, loaded | 0.802 |
| Net register | 4,398 tons. |
| Gross register | 7,245 tons. |
| Deadweight capacity | 10,250 tons. |
| Displacement, loaded | 14,760 tons. |
| Capacity main cargo tanks | 72,670 bbl. |
| Capacity of summer tanks | 10,476 bbl. |
| Capacity of dry cargo | 35,883 cu. ft. |
| Fresh water | 255 tons. |
| Capacity fuel oil | 964 tons. |

### Principal Engine Characteristics

| | |
|---|---|
| Total power | 2900 b.hp. |
| Type | 2-cycle |
| Injection | Air |
| Number of cylinders | 6 |
| Bore | 27 in. |
| Stroke | 60 in. |
| Speed | 85 r.p.m. |
| Crankshaft diameter | 21 in. |
| M.i.p. | 90 lb. per sq. in. |



*Top of Lio's 6-cylinder 2900 s.hp. engine, as seen on the upper grating, looking from the forward end of the engine room casing*



*Plan of the machinery space in the big single-screw tankship Lio, showing the disposition of the main engine and auxiliary sets*

Compression pressure .....450 lb. per sq. in.
Maximum pressure .....490 lb. per sq. in.

### Observed Data on Trial Trip

Circulating water .....25 lb. per sq. in.
Fuel supply pump .....30-40 lb. per sq. in.
Lubricating oil .....20-25 lb. per sq. in.
Scavenging air .....1¾-3 lb. per sq. in.
Air compressor—l.p. stage ....45 lb. per sq. in.
Air compressor—i.p. stage ...225 lb. per sq. in.
Air compressor—hp. stage ...800 lb. per sq. in.
Piston cooling .....10 to 15 lb. per sq. in.
Starting air receiver .....325 lb. per sq. in.
Cooling water outlet temp.,
80 deg. to 110 deg. F.

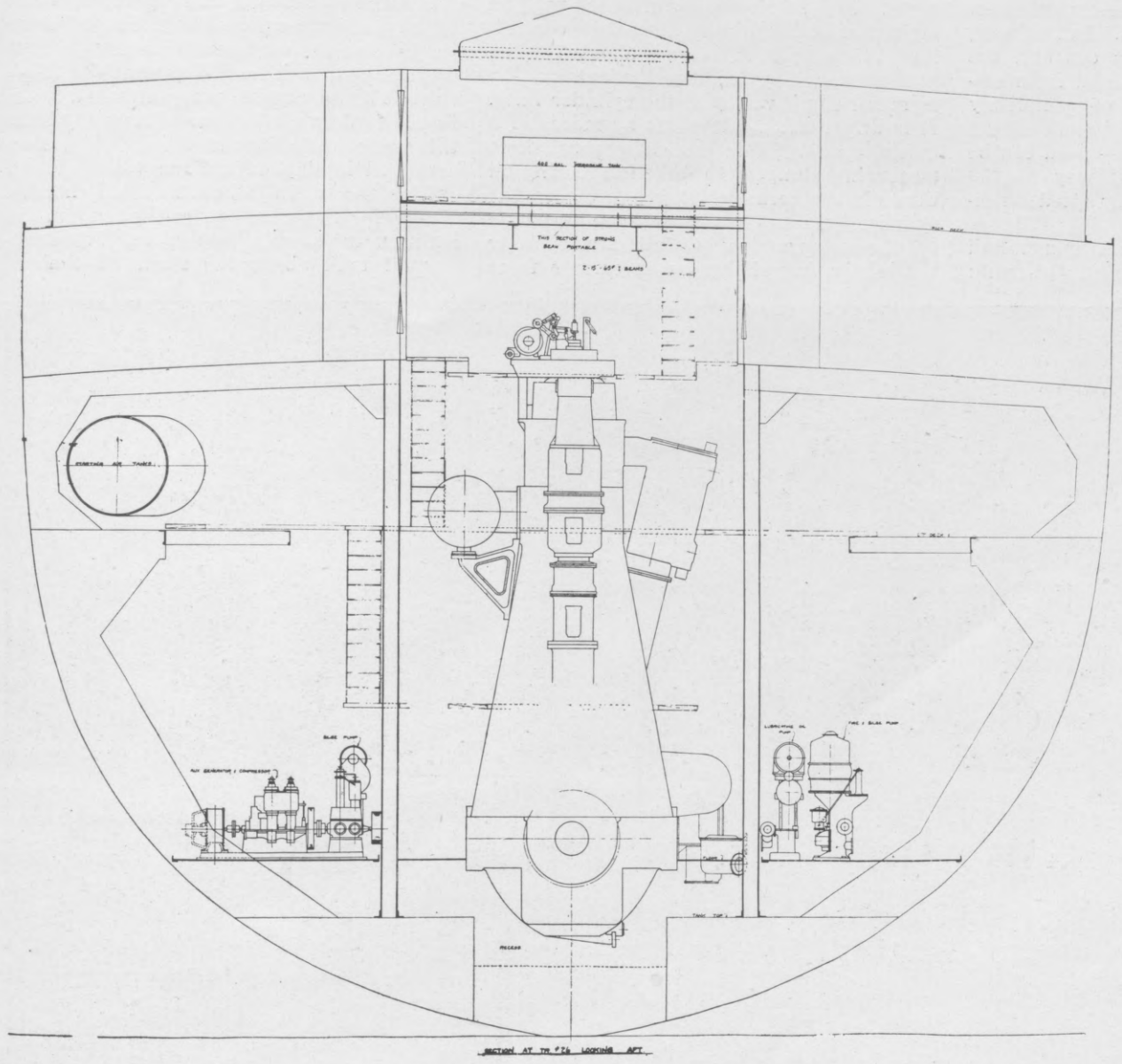
Cylinders are arranged in pairs, permitting the bedplate and housing for each pair of cylinders to form a complete unit. The cylinder block supporting two cylinder liners is made of cast steel, and separate sleeves are inserted in the cylinder block to form the water jacket with the liners. The cylinder block, therefore, is not required to seal the cooling water. The frames are of cast iron, and the bedplate of cast steel bored to receive round cast iron main bearing shells lined with white metal. The crankshaft is entirely built up and is bolted together in three sections, each section having cranks on opposite centers and the bolting flanges being placed inside of two main bearings.

Cylinder liners are of the Bethlehem bottle neck type designed to permit free expansion where the heat of combustion is most intense. A downward-opening, single scavenging valve is fitted in the throat of the neck and provides uniflow scavenging through the cylinder to the exhaust ports, which are cored completely round the circumference of the cylinder liner at the lower extremity. This liner construction is advantageous for machining, because it allows a boring bar to pass through the complete liner, thus permitting floating reamers to accurately bore the entire cylinder wearing surface.

Three scavenging pumps are inclined against the back of frames Nos. 2-4 and 6, and are operated by connecting rods attached to the main connecting rods near the lower T end. These pumps are double-acting, with the suction valves inside silencers on each end of the scavenging pump cylinders. Common discharge lines connect the scavenging pump cylinders at approximately the center of the cylinders making connections with the scavenging air boxes on the cylinder heads. Breaking plates are provided on the two outside scavenging pumps in case explosive pressures should back up in the scavenging pump cylinders.

The fuel valves are placed in the center of the scavenging valves. Each valve is arranged with a micrometer screw adjustment, so that the lift of the fuel needle can be adjusted while the engine is in operation. A unique type of pulverizer, in which rings are milled out to provide wetted surface, is placed at the lower extremity of the fuel valve needle. The scavenging valve rocker shaft is placed on eccentrics to permit the adjustment of the scavenging valve clearance while the engine is in operation. The design of the cams, rockers, etc., for the scavenging valves, permits of very smooth and quiet operation.

The main pistons are in two parts. The portion adjacent to the combustion chamber is made of special forged steel with a hemispherical top, and is bolted to a long cast iron sleeve serving as the piston rod. The cast iron sleeve, being directly connected to the crosshead, therefore transmits the gas pressure from the piston crown to the crosshead. The tubes carrying the piston cooling water to and from the pistons are attached to the cast iron sleeve, but the steel



head of the piston is the only portion provided with water-cooling. Telescopic tubes, packed with chemically impregnated cup leathers, provide a seal against leakage of the cooling water to the crankcase. Fresh water is employed as the cooling medium, and a large fresh water cooler is attached to the bedplate below the center scavenging pump. The crossheads are of the double guide type.

The air compressor is of the 3-stage, 4-cylinder type, with two low pressure pistons, one intermediate and one high pressure piston. The hp. piston is on top, one l.p. piston on the next step below, the other l.p. piston on the next lower step and the i.p. piston on the lowest step directly above the crosshead. One l.p. stage is provided with a suction inlet control which determines the final capacity of the compressor. The other l.p. stage constantly draws the same amount of air from the engine room into its cylinder. The suction and discharge valves on each stage are placed in a vertical position, the suction valves being placed underneath the discharge valves. Each stage is provided with tube type intercoolers, suspended from a top flange and provided with stuffing boxes at the lower flange. Moisture and oil traps are provided on the discharge end of each intercooler.

The camshaft is provided with one set of cams for each cylinder and is operated from a vertical shaft on the after end of the engine, driven by bevel gears from the main crankshaft. The upper end of the vertical shaft is provided with a reversing mechanism which turns the camshaft through an angle of 34 deg. to accomplish reverse timing of the camshaft. Each cylinder is provided with one scavenging air cam and one fuel cam and one to operate the air starting control valve alongside the cylinder head. A horizontal layshaft alongside the camshaft permits the air starting valve to be operated for ahead or astern timing. In this way one control valve, one cam and two rollers are used on each cylinder for pneumatically actuating the starting valve.

Control of the engine is centralized in three levers at the control stand. The left hand lever is the starting air lever, the center lever is the main maneuvering lever and the right hand lever controls the lift of the fuel valve needles. When the center or maneuvering lever is shifted over to the right-hand slot for ahead or to the left hand slot for astern, the valve-timing mechanism is correspondingly placed in the ahead or astern running position. Starting air is then admitted by the starting air lever to the engine cylinders, and further movement of the maneuvering lever causes the fuel pumps to function. A gradual advance of the maneuvering lever and of the fuel valve lift control increases the amount of fuel and adjusts the opening of the fuel valves to the load. When cylinders have started firing, the starting air lever can be withdrawn, thus dropping the air starting control valves out of engagement with their respective cams. Interlocks are provided on the main maneuvering lever to guarantee the correct movement of the maneuvering cylinders for the desired timing.

The fuel pumps are placed on top of the main cylinders and driven horizontally by eccentrics from the camshaft between cylinders 4 and 5. Each pump is provided with its individual control mechanism for seating the suction valve, and each suction valve is provided with a cut-out valve permitting the engineer to shut off the fuel from any cylinder at will. The pumps are also arranged so that the fuel supply to any individual pump can be cut out at will, thus permitting the regrinding of suction or discharge valves while the remaining pumps are in operation. A single priming pump is used to prime the fuel line to each fuel valve. Fuel is furnished to the suction manifold of the pumps under pressure from the fuel supply pumps located on the floor plates. In this way a constant oil pressure is provided under the suction valves of each fuel pump plunger regardless of the oil level in the daily service tanks.

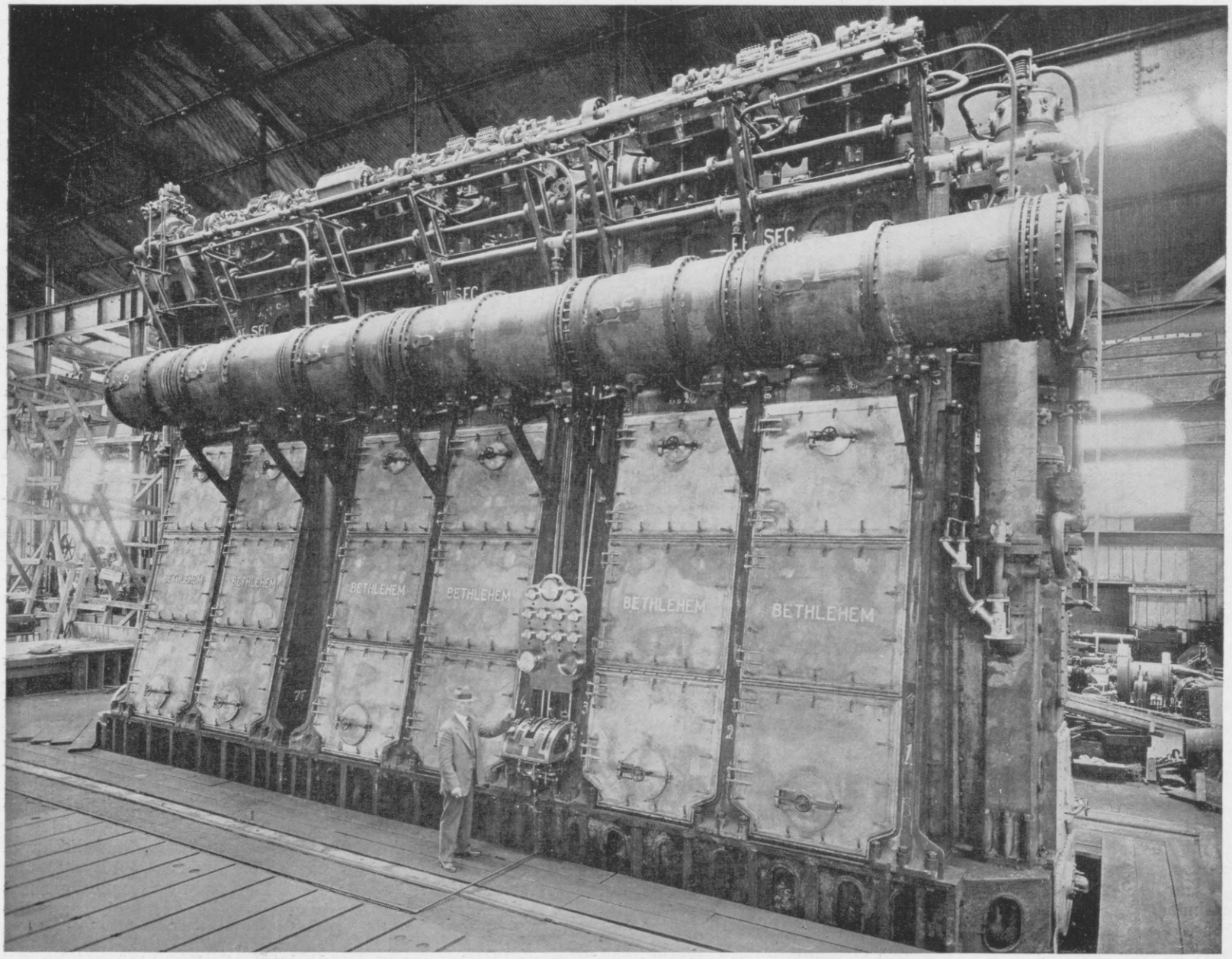
The day tanks are located on the main deck level immediately forward of the engine room. One of the small motor driven fuel transfer pumps draws fuel oil from the settling tanks and discharges it under pressure to the Sharples Pressuretite purifiers. From the centrifuges the fuel is delivered to a small sump immediately below. The other transfer pump is arranged to draw from the fuel sump and discharge in the day tanks. The fuel oil supply pump driven from the main engine crankshaft draws fuel from the day tanks and discharges it into the suction chamber of the engine fuel pumps on top of the engine. This arrangement is particularly advantageous when heavy fuels are used, because the fuel supply pumps will maintain a constant circulation of heated fuel through the fuel lines to the suction valves of the fuel pumps, regardless of the speed of the engine. This arrangement also permits the venting of air or gas from the fuel pump supply line.

A Ramsay combined anticipating and inertia governor is arranged to control the fuel pumps. A control shaft underneath the suction valves of the fuel pumps is connected to the operating cylinder of the Ramsay governor and is notched at various angular positions in such a way that the governor will not cut out all of the cylinders at the same time. The scheme is somewhat similar to that used on a steam turbine; cylinders 3 and 4 are first cut out when the Ramsay operating cylinder begins its outward movement, and, as this outward movement continues, cylinders 2 and 5 are

next cut out and finally in the extreme case cylinders 1 and 6 are cut out. In this way, with the cylinders gradually cut out, the speed of the engine is prevented from rising, without the necessity of completely cutting off fuel from all of the main engine cylinders. Therefore, an over-speed can be easily checked in a gradual way as the governor anticipates changing speed conditions.

Main bearings, crankpin bearings and crossheads are lubricated from the main ports. This lubricator is furnished with an air manifold containing air valves controlling the supply of air at about 150 lb. pressure to a point directly outside the terminal check valves in the cylinder liner. It is driven from a layshaft by means of a quick opening cam which causes three measuring plungers to force lubricating oil through the terminal check valves in the cylinder liner to the upward moving piston on the compression stroke. Immediately the lubricating oil begins to emerge from

A large lubricating sump pump operated by an eccentric draws lubricating oil from the base of the engine and discharges it to a cylindrical tank located against the ship's side. The lubricating pump attached to the forced-feed manifold draws its supply from this tank and discharges into oil coolers arranged in duplicate, from which the o enters the main lubricating oil header. Water for these coolers is taken from the main engine circulating system. A secondary oil tank above the main oil tank is




*Main engine of the Lio, a 6-cylinder 2-cycle single-acting set, developing 2900 s.hp. at 95 r.p.m.*

forced feed system. At sea a lubricating oil pump driven from the engine crankshaft supplies lubricating oil to the main lubricating oil manifold, but when leaving or entering port the attached pump can be disconnected and a separate electrically driven vertical plunger pump connected to the lubricating oil manifold.

The cylinders are lubricated at two different levels. Bowser lubricators on top of the engine cylinders lubricate the cylinder liners below the exhaust ports, three lines, containing terminal check valves, furnishing lubricating oil to the rings in each cylinder as the piston approaches bottom dead center.

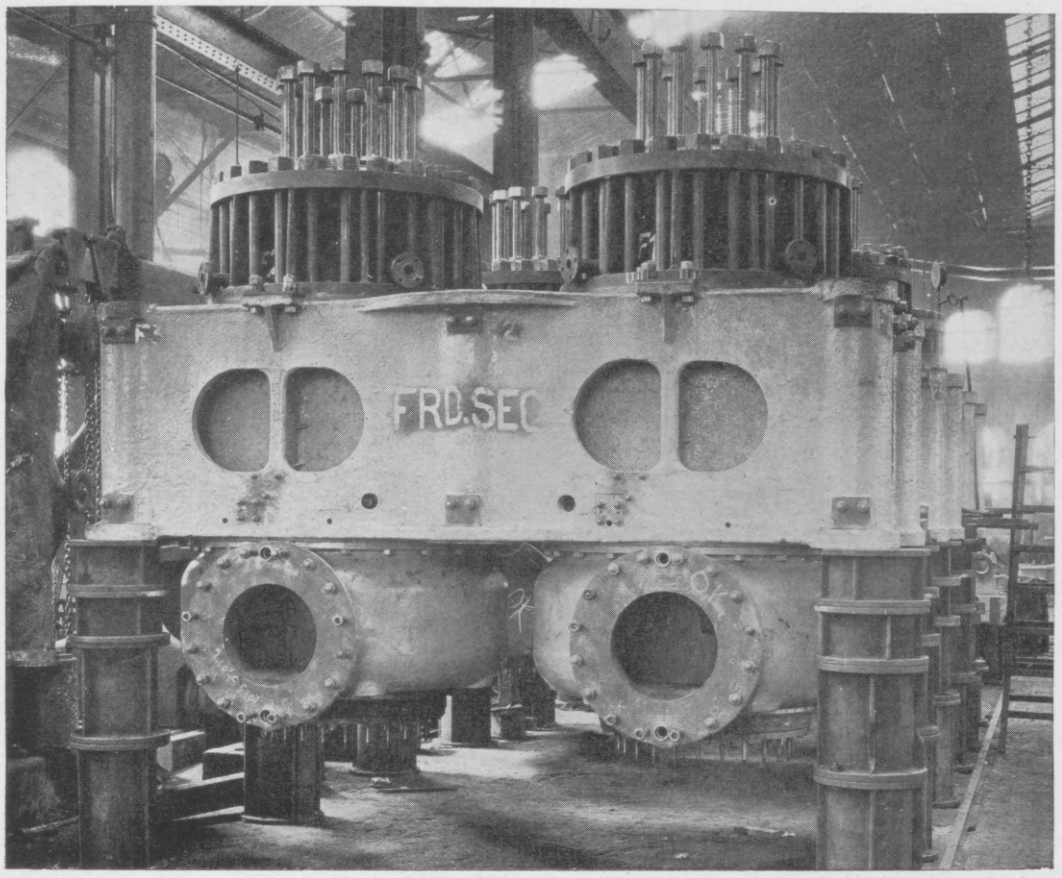
Another independently driven Bowser lubricator is placed in front of each cylinder to lubricate the piston above the exhaust

the seat of the terminal check valve, the air valves are opened and air at about 150 lb. pressure sprays the lubricating oil on the piston rings. A very short time is available for this action, and therefore a very fast operating arrangement is essential, together with short lubricating oil and air lines.

The lubricators on top of the cylinders also lubricate the scavenging valve guide and the fuel valve guide. Lubrication of the valves is therefore automatic and properly measured and controlled. The valve rockers and pins are provided with Alemite fittings so that lubricant at positive pressure reaches the wearing surface of the valve gear. For the pistons of the air compressor the same system is used as for the power cylinders.

fitted with heating coils to prepare the oil for the Sharples lubricating oil purifier, after issuing from which it is returned to the lubricating system via the sump tank.

The cooling water is arranged with four separate outlets from each cylinder. Each outlet is piped to an overflow indicator which shows through a sight glass whether water is passing through and indicates the temperature on a thermometer. The four outlets are from the exhaust header, fuel valve, scavenging valve and cylinder jacket respectively. Because of the proximity of the scavenging valve and of the fuel valve to the combustion space and due to the fact that the fuel valve is a considerable distance away from the cylinder water jacket, it is necessary to cool both the scavenging valve seat and the fuel valve body.



*Cylinder block assembly of distinctive type described in text*

Five auxiliary pumps are operated by the main engine through gearing from the crankshaft. They are of the double-acting type operated by an overhead crank which can be disengaged by means of a claw clutch when the vessel enters port or during the time when maneuvering of the main unit is necessary. These pumps are for the jacket water, piston water, lubricating oil, fuel oil supply and bilge respectively. Thus the vessel at sea can be operated with but few independently driven auxiliaries in operation.

The following motor driven auxiliaries have been installed on the LIO:

### List of Motor Driven Auxiliaries

1 Bethlehem-Weir upright circulating pump.
1 Bethlehem-Weir plunger lubricating pump.
1 Bethlehem-Weir centrex fire & bilge pump.
1 Bethlehem-Weir plunger fuel oil supply pump.
1 Bethlehem-Weir centrex sanitary pump.
1 Bethlehem-Weir centrex fresh water pump.
1 Bethlehem-Weir plunger oil transfer pump.
1 Bethlehem-Weir plunger boiler-feed pump.
1 horizontal plunger piston cooling pump.
1 horizontal centrifugal sanitary pump.
2 horizontal plunger fuel transfer pumps.
1 Bethlehem-Weir 3-stage starting air compressor.
2 Sharples fuel oil separators.
1 Sharples lubricating oil separator.

Current for driving the electric motors is furnished by three Bethlehem Diesel generating sets of 100 b.hp. each, driving 65 kw. d.c. 240 volt generators. These engines are of the 4-cylinder, port scavenging, 2-cycle type, with scavenging air furnished by a double-acting pump attached to one end of the crankshaft and discharging into a manifold which communicates with the scavenging ports in the cylinder walls. The fuel system is of the airless injection type. A gear driven plunger pump furnishes fuel at 3000 to 4000 lb. per sq. in. pressure to a manifold which supplies the fuel valves. The speed of the engine is controlled by varying the lift of the fuel valve needles, and the governor control regulates the lift of the four valves simultaneously.

The Bethlehem-Weir 3-stage auxiliary air compressor replenishes the two main starting air tanks through reducing valves. This compressor is also designed to furnish injection air for the main unit when operating at two-thirds capacity.

A 15 hp. Mianus engine, with a generator on one end of the crankshaft and a Rix high pressure emergency air compressor on the other end is installed on the switchboard flat aft of the main engine.

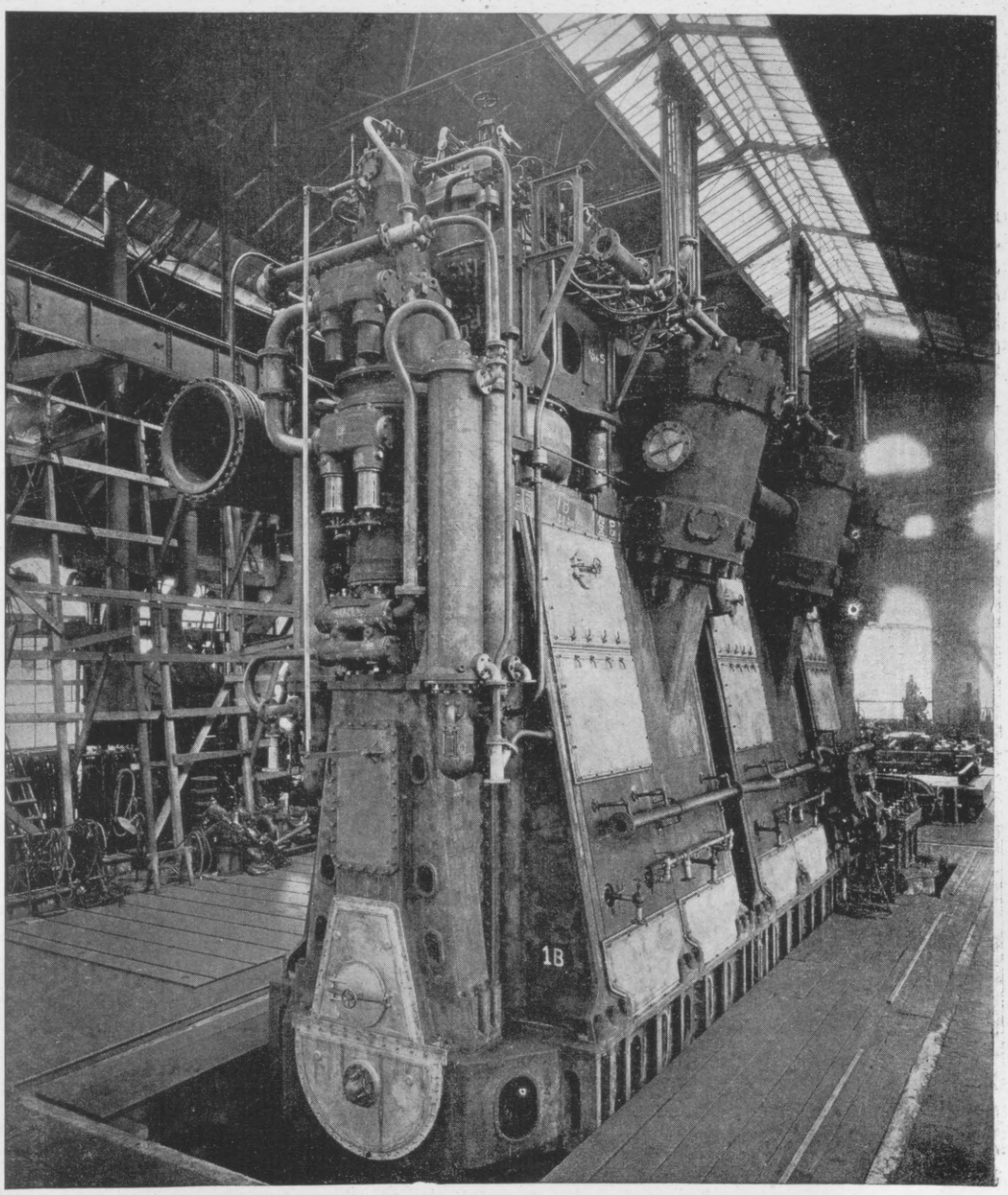
A 2-ton Brunswick motor-driven refrigerator set is installed close to the ice boxes, the refrigerator room being directly aft of the main engine room.

On the port side of the main engine room is installed the steam plant, salvaged from the original installation and comprising:

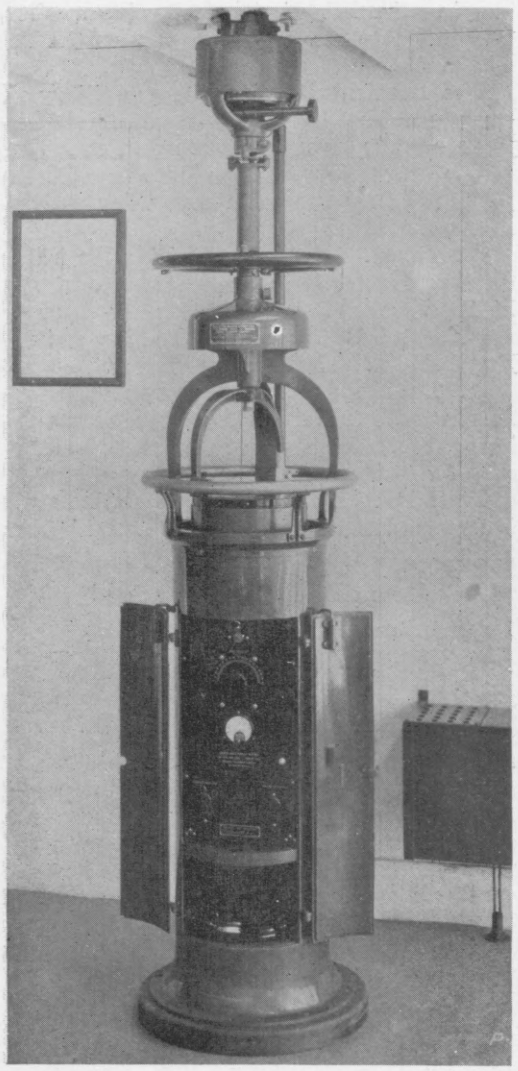
### Steam Equipment Retained

| | |
|---|---|
| 1 main boiler | 1 injector |
| 1 feed pump | 1 aux. condenser & pump |
| 1 feed water heater | 2 fuel oil pumps |
| 2 cargo pumps. | 4 cargo winches. |

At sea only one auxiliary generator set is required to furnish current to the steering gear, ice machine, fresh water pump and fuel oil transfer pump. An exhaust gas generator is arranged on a level with the muffler and is provided with butterfly valves so that a portion of the exhaust gases can



*Compressor at forward end and scavenge air pumps on the back of the Lio's engine*



*Kolster radio direction finder on Lio*

be deflected through the steam generator. This generator or boiler is also fitted with a Ray oil burner for raising steam when the main engine is not operating. The steam generated in this boiler is used for heating quarters, for the galley, etc., and an arrangement is also provided for heating the water in the main boiler preparatory to raising steam for operating cargo pumps.

An electric anchor windlass of Allan Cunningham build with warping heads on the intermediate shaft is driven by a 75 hp. General Electric totally enclosed marine motor. The magnetic contactor control panel is located below deck and actuated by a master controller located alongside the windlass. A powerful solenoid brake holds when the controller is placed in an off position. A warping winch of the Allan-Cunningham double geared electric type is provided for handling the stern lines. Extension shafts are fitted with drums from which wire rope can be led to the tiller for steering in the event of accident to the regular steering gear.

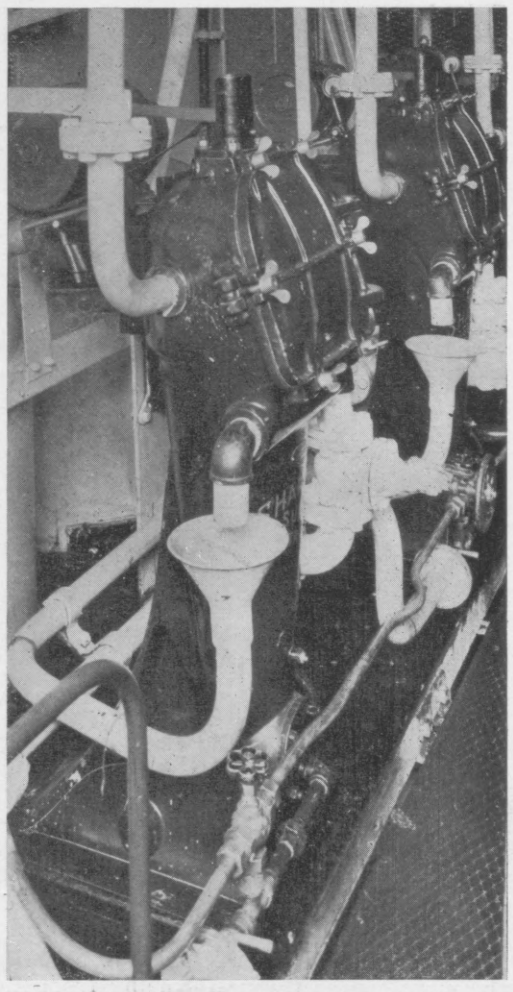
On the main mast a 12 in. Cunningham disc type compressed air whistle is fitted. It uses air from the main maneuvering tanks through a reducing valve at about 125 lb. pressure.

A 12 in. Bethlehem hydro-electric steering gear has been installed with the original telemotor control from the wheelhouse. It can also be controlled by the Metal Mike. An emergency steering wheel is fitted on the poop deck for operating the steering engine. Helm angle indicators are fitted both on the bridge and on the poop deck.

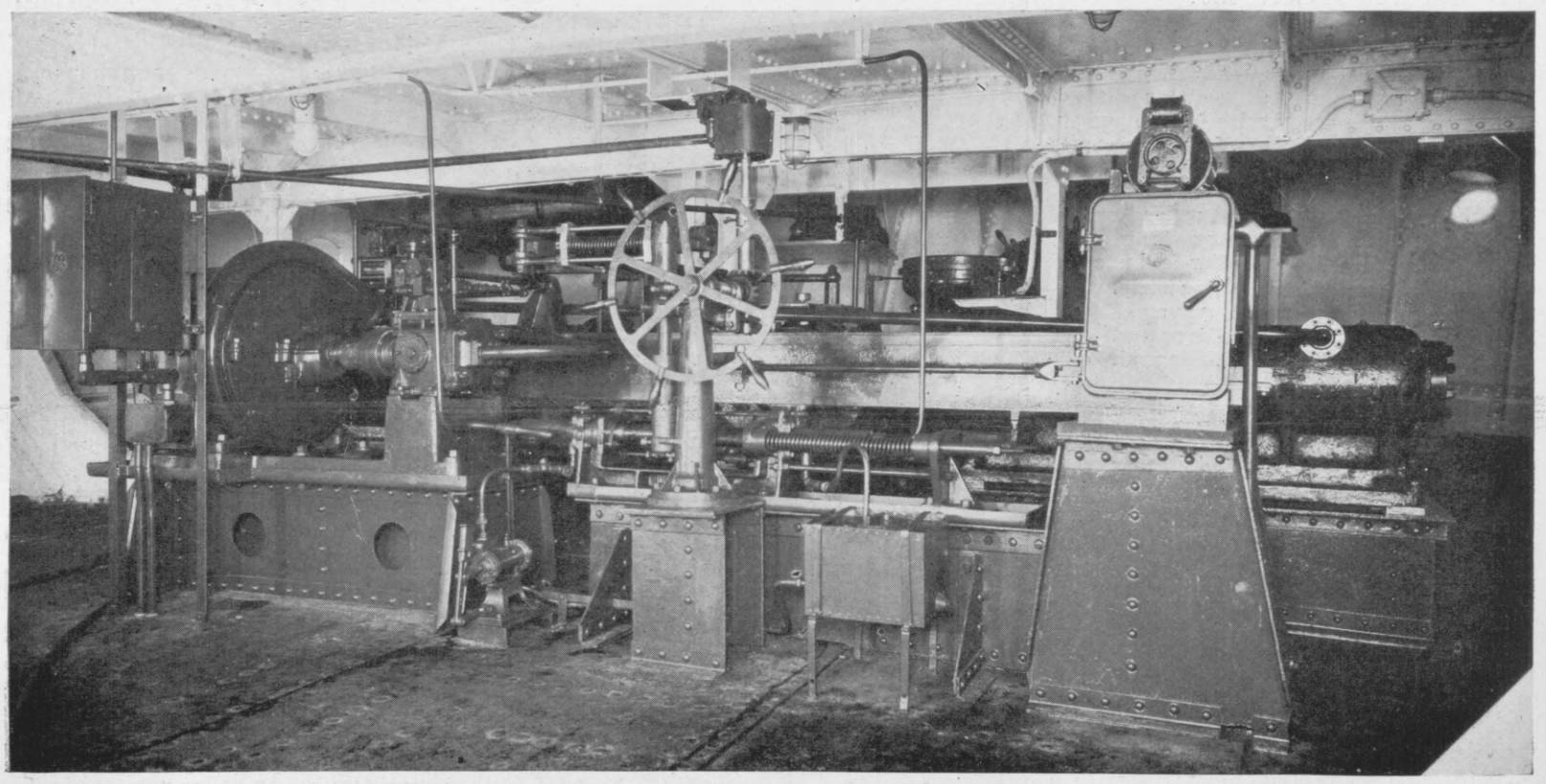
LIO is equipped with the latest type of Kolster radio direction finder. A new radio tick system has also been installed by the Federal Telegraph Company. A new feature included in the latest model Kolster direction finder is an apparatus permitting two persons to listen in at the same time, this feature being of value in giving instructions in the use of the radio compass. A Sperry repeater is installed in the direction finder.

A Sperry 2-unit gyro-pilot has been installed. It in no way displaces the original steering arrangement but is provided as an automatic steering apparatus entirely independent of the telemotor system. The mechanism is divided, so that the contact and control gear is on the bridge and the power unit attached to the steering gear. The power unit, therefore, operates the valve on the steering engine direct. Any lost motion in the telemotor system has no effect on the operation of the steering gear. The ship has, therefore, two distinct systems for controlling the steering so that in the event one fails the other will be available.

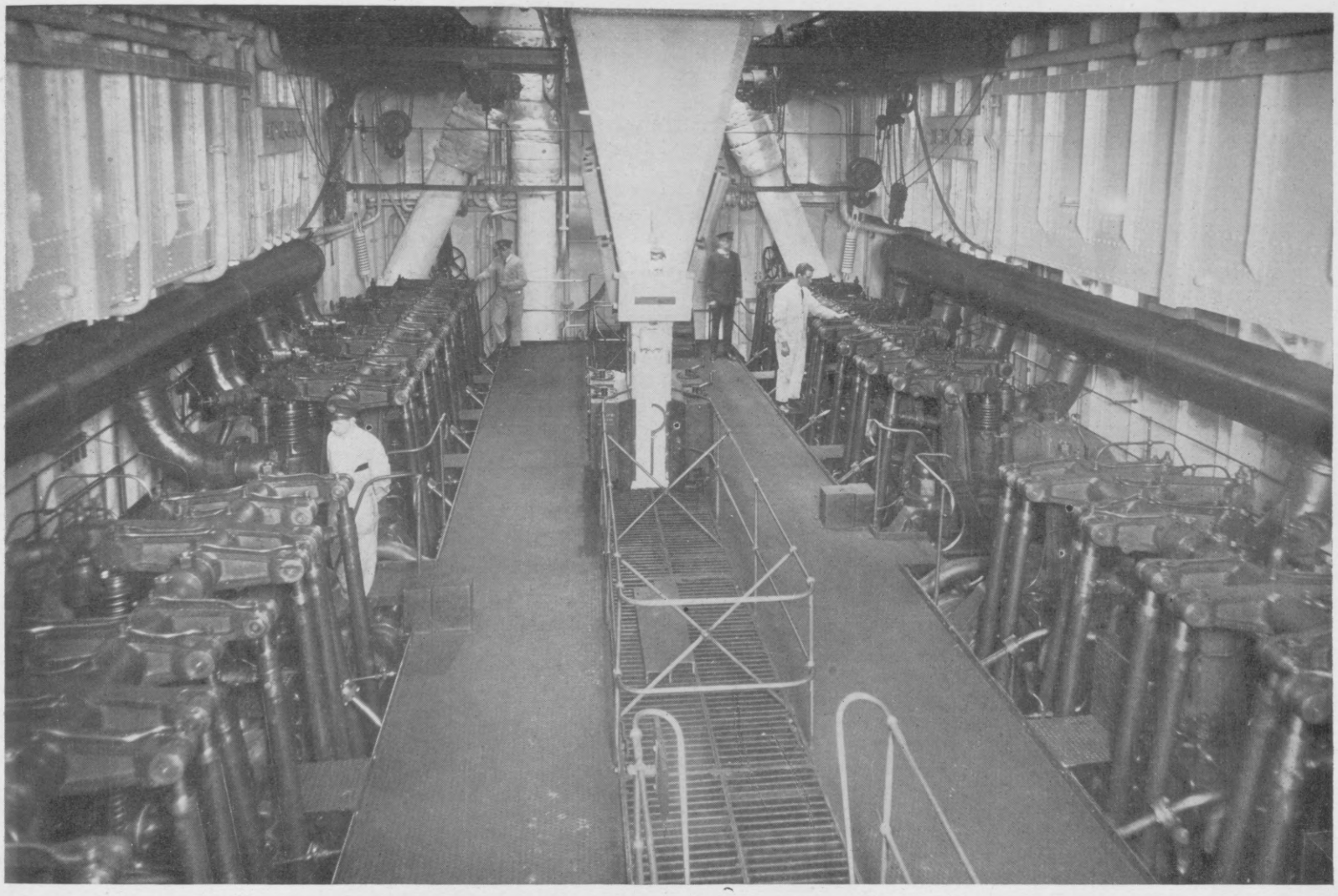
(*Continued on page* 222)

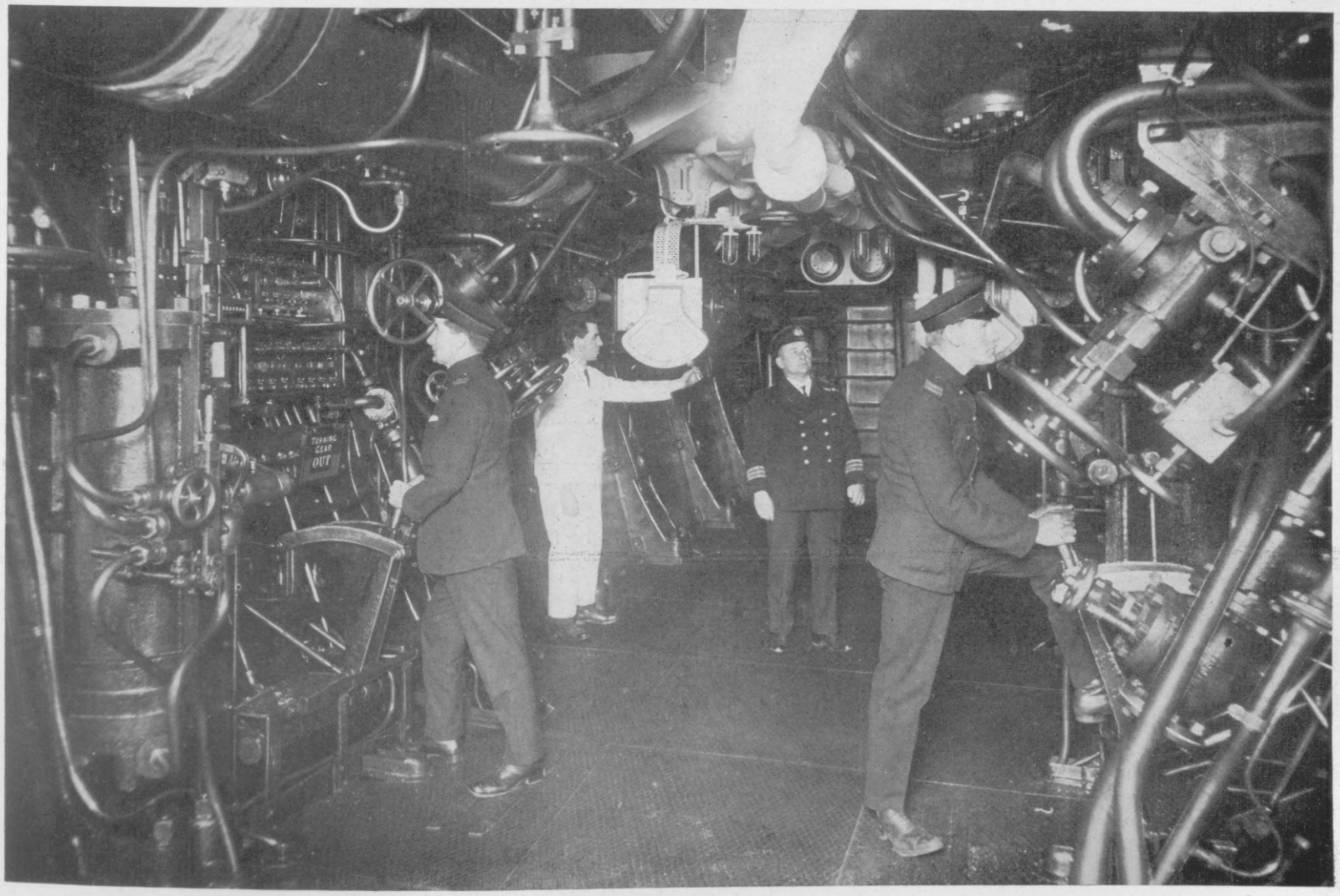


*Sharples Pressuretite fuel centrifuges on Lio*



*Lio's electric hydraulic steering engine, adapted to gyro pilot direct control and to telemotor control*






*Engine room of the Royal Mail Steam Packet Company's twin-screw motorliner Asturias* (22,500 *tons gross*) *with Harland & Wolff-B. & W. 8-cylinder, 4-cycle double-acting engines of* 20,000 *i.hp. aggregate. The most powerful Diesel engines yet commissioned*

## General Petroleum Motortanker Lio

(*Continued from page* 220)

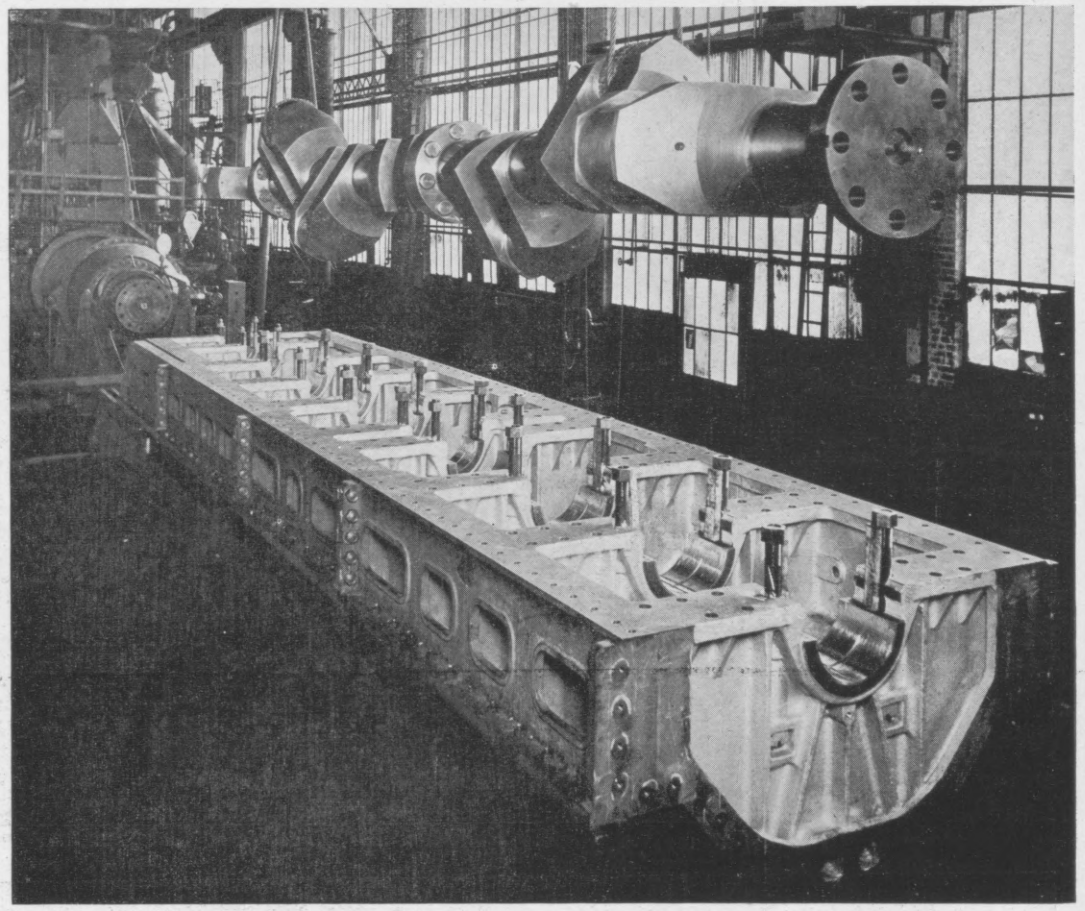
A Lux fire extinguisher system is installed and no steam smother lines are provided, entire confidence being placed in the Lux carbon dioxide system for controlling any fires that may occur in the ship. The installation consists of 10 banks of 10 cylinders each, all fitted with a piercing valve operated by a lever attached to a cable. The cables controlling each bank are brought up to the bridge deck, where any bank can be opened to smother a fire, no matter where it occurs. A pull on the cable gives the levers in each bank of cylinders a short arc movement which causes a cutting attachment to pierce a diaphragm and release the carbon dioxide liquid from the bottles into the manifold. The piping is so arranged as to keep the carbon dioxide in liquid form until it reaches the outlet nozzles where it instantly changes to a gas. One cubic foot of liquid carbon dioxide become 450 cu. ft. of gas upon release. Each cargo oil tank is provided with its bank of cylinders, and lubricating oil storage and fuel tanks are also provided with suitable banks. Two banks are arranged to deliver carbon dioxide to the engine room, and lines are also distributed to the refrigerator room and engine room paint locker. By this system any threatening conflagration can be smothered before it reaches the danger point.

The quarters of the LIO have been completely reconstructed and rearranged. Every effort has been made to provide as much comfort as possible for the officers and crew. The officers' quarters are well appointed, and every consideration has been given to the comfort of all on board.

## Four 3000 s.hp. Engines

At the Busch-Sulzer Bros. Diesel Engine Co.'s plant at St. Louis, Mo., the erection of the second 3000 s.hp. engine for the Shipping Board is well under way—the first engine will be on test all this month under full power. In the picture above, the first 3000 hp. engine is in the background; in the foreground are the bedplate and crankshaft of the second engine. Four of these engines were ordered by the Shipping Board, and they are the only 2-cycle single-acting engines incorporated in the conversion program. They are 6-cylinder sets, designed to develop 3000 s.hp. at 90 r.p.m., and the cylinder dimensions are 30 in. x 52 in. Sulzer type engines are generally rated on a higher m.i.p. than the Shipping Board specified, and these Busch-Sulzer engines are well within their maximum power limits.

Another Australian company will shortly take delivery of a motorvessel, Burmeister & Wain having launched in Copenhagen the hull of the MOMBA, a vessel of 5,000 tons d.w. with 2500 i.hp.



*Crankshaft and bedplate of 6-cylinder 3000 s.hp. Busch-Sulzer engine*



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